# MANUAL

ON THE

# CULTIVATION OF THE SUGAR CANE,

AND THE

# FABRICATION AND REFINEMENT

OF

# SUGAR.

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PREPARED UNDER THE DIRECTION OF THE HON. SECRETARY OF THE TREASURY, IN COMPLIANCE WITH A RESOLUTION OF THE HOUSE OF REPRESENTATIVES OF JAN. 25, 1830.

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1833.

WASHINGTON, MAY 28, 1833.

*To the Hon.* LOUIS MCLANE,
*Secretary of the Treasury.*

SIR:

In accordance with the request contained in your letter of August 31st, 1832, I now have the honor to offer, for your consideration, a report drawn up in compliance with the resolution of the House of Representatives of January 25th, 1830—in which the Secretary of the Treasury was instructed "to cause to be prepared a well digested Manual, containing the best practical information concerning the culture of the Sugar Cane, and the fabrication and refinement of Sugar, including the most modern improvements."

Agreeably to the permission contained in your letter of October 18th, 1832, I have employed such assistance as I have found necessary in the execution of the duty. Mr. C. U. Shepard has, with this view, visited Louisiana, and other districts in the South, where the sugar cane is cultivated: Mr. O. P. Hubbard has examined the refineries in Boston; and I have myself visited some of the principal establishments of this kind, in Baltimore, Philadelphia and New York, aided, in the latter city, by Mr. G. S. Silliman. Correspondence has, in the meantime, been extended to those parts of the United States, where sugar is fabricated or refined. The printed reports, transmitted from the Treasury department, have been attentively considered; and the best sources of information, in treatises and journals, have been explored.

The investigation in the South was prosecuted with the understanding, that it was necessary to communicate the document to the House of Representatives during the late session of Congress, and it was not known, until Mr. Shepard returned to the North, that more time could be allowed. Had we been aware of this, the investigation in the South might have been more extended, and possibly, more satisfactory.

In the hope however that the Manual may, in some degree, answer the design of the government, I have the honor to remain,

Very respectfully,

Your most obedient Serv't,

B. SILLIMAN.

## INTRODUCTORY REMARKS.

For the facts obtained from Louisiana and Georgia, Mr. C. U. Shepard, who was deputed to these districts in November, 1832, expresses himself indebted to the following gentlemen, who either afforded him information or assistance in the prosecution of his inquiries: Mr. Joseph Saul, Mr. William Montgomery, Mr. J. H. Shepherd, Mr. Stephen Henderson, Messrs. Gordon, Forstall & Co., Mr. Thomas A. Morgan, Mr. J. Penny, Mr. J. J. Coiron, Mr. Jules Villeré, Mr. Caliste Villeré, Mr. Delphine Villeré, Mr. G. B. Milligan, Mr. Laurent Millaudon, Mr. Samuel Packwood, Mr. Henry McCall, Governor Romain, Mr. Eustis, Dr. Lewis Heermann, Judge Porter, Mr. Avequin, Judge Winchester, Col. Nicholas, Mr. James Porter, and Mr. V. Allain, in Louisiana; and to Mr. Gaston, Mr. J. H. Couper, Mr. Grant, Mr. Stockton, Mr. McIntosh, and Rev. Mr. Pratt, in Georgia. He desires however, not to be understood as holding these gentlemen responsible for the statements he makes, or the opinions which he advances: while he would attribute all that may be deemed just in his observations to opportunities and suggestions afforded by them, he assumes any errors into which he may have fallen, as exclusively his own; and would hope for some indulgence from the difficulties of the undertaking, and the limited period allowed for his researches.

# PART I.

## ORIGIN AND HISTORY OF THE SUGAR CANE.

Concerning the origin of the Sugar Cane, there is some diversity of opinion. While none have doubted that it is indigenous to China, where it has been cultivated for more than twenty centuries, it has been contended by some, that it existed in South America, Mexico, and even in Louisiana, prior to the discovery of these countries by the Europeans. This opinion appears to be countenanced by the following evidence.

Father Labat affirms, in his Histoire d'Amerique, that the Cane was seen growing in Brazil, by many travellers, prior to the year 1580; Jean de Lery declares that he found a great quantity of it near Rio Janeiro, in 1556; and Father Hennepin asserts that the banks of the Mississippi, for thirty leagues from its mouth, were full of Canes in 1680. With respect to the testimony of Labat and Jean de Lery, it may be said, that it would be surprising if the Portuguese had failed to introduce the Sugar Cane into Brazil before those dates, when it had been seen to flourish for at least thirty-five years at a distance no greater than that of the island of St. Thomas. The plant taken by Hennepin for Sugar Cane, upon the banks of the Mississippi, was undoubtedly nothing more than a species of Bamboo, called the Wild Cane. (*Miegia macrosperma.*)

The ancient Egyptians, the Phenicians, the Jews, the Greeks and the Romans, had no knowledge of the Cane. The plant of which Lucan says,

"Quique bibunt tenera dulces ab arundine succos,"

and probably that alluded to in Isaiah xliii. 24—"Thou hast brought me no sweet cane with money"—was a species of the Bamboo. The Cane passed into Arabia only at the close of the thirteenth century, at the time when the merchants of that country who were engaged in commerce with India, emboldened by the example of Marco Paulo, undertook to supply themselves with the commodities of the East, from whence they brought the Sugar Cane, which was cultivated at first in Arabia, afterwards in Nubia, and finally in Egypt and Ethiopia.

The introduction of the Cane from the East into Europe took place about the year 1148; ever since which date it is known to have been cultivated more or less extensively in Sicily. By some writers it is maintained, that the Saracens brought it directly from China to that island; while others prefer the opinion of its previous introduction into the island of Cyprus, where it is known to have been cultivated at a very early period, and from whence they suppose it passed to Sicily. Lafitau mentions the present made by William II., king of Sicily, to the convent of St. Bennett of a mill for grinding Sugar Canes, accompanied by the royal privilege, workmen and appurtenances,—the donation bearing the

date of 1146.* About the year 1420, Don Henry, regent of Portugal, transplanted the Cane from Sicily to Madeira; where it succeeded perfectly, and spread throughout the Canary islands, from which all Europe derived its supply of sugar till the discovery of America. From the Canaries, the Cane was carried to Hispaniola, now called Hayti, in 1506; and about the same time, to Brazil. Towards the middle of the seventeenth century, it was introduced from Brazil into Barbadoes; where the sugar it afforded is said to have been at first so inferior, as scarcely to be worth sending to England. In 1643, sugar began to be made by the English in St. Christopher, and in 1657 by the French in Guadaloupe. In 1656, there were only three small sugar plantations in Jamaica. About this period also, the Cane was introduced into the Dutch and Danish colonies, and into Mexico, Peru, and Chili.

The Sugar Cane was first brought into the United States from Havanna, by Mr. Boree of Louisiana, with the intention of cultivating it solely for the manufacture of rum; but on the evaporation of the syrup it was perceived that it would afford sugar, and this gave origin to its culture for the fabrication of sugar in this country.

## [illegible]R AND DESCRIPTION OF THE [illegible]AR CANE.

[illegible]he second tribe of the monocotyledonous [illegible]d is characterized by the want of a true [illegible]oom of which, the floral envelopes are [illegible] The Glumaceæ are divided into two [illegible]Graminæ, or Grasses, to the latter of [illegible]—the family being distinguished by slit [illegible]on the outside of the albumen, with a naked [illegible] Robert Brown has associated Saccha[illegible]era into a sub-family, called the Panaceæ; [illegible]pogon, Anthesteria, Cenchrus, Isachne, Panicum, Paspalum, Kermaria, Antherantia, Monachne, Lappago, and several other related genera,—the character being a locusta of two flowers; of which the lower or outer is uniformly imperfect, being either male or neuter, and then not unfrequently reduced to a single valve.

The character and description of the genus is as follows: two calycinal valves, (sometimes wanting) furnished exteriorly at their base with a long and silky down, and containing but a single flower; two floral valves, three stamens and two styles; flowers disposed in panicles, usually presenting a delicate appearance from the fine down with which they are abundantly clothed. The Saccharum approaches the Reed (genus *Arundo*); but differs from them, inasmuch as these have their down within the calycinal valves, while in the Saccharum, it is inserted upon the outer side. The genus contains a number of species. There is but one, however, which is cultivated for sugar: the others are remarkable on account of their size, and some of them for the uses to which they are applied.

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* According to Lafitau, the Cane was brought into Europe at the time of the crusades. Albert Aquenus, in the description which he has given of the processes employed at Acre and Tripoli in order to extract the sugar, says, that in Palestine, the crusaders, being destitute of provisions, had recourse to the Sugar Canes, which they sucked for sustenance.

The species called the Sugar Cane is the Saccharum officinarum. The following is a general description of it: Root jointed, sending forth four or more shoots, proportionable to the age or strength of the root, and the goodness of the ground. The height is from eight to ten feet, and in moist, rich soil, nearly twenty feet. The stem is jointed, and the joints are more or less distant, in proportion to the quality of the soil. The leaves are flat, having a deep, whitish furrow, or hollowed mid-rib, which is broad and prominent on the under side; the edges are thin, and armed with small sharp teeth, which are scarcely to be discerned by the naked eye, but will cut the skin of a tender hand, if drawn across it. A leaf is placed at each joint; and the base of it embraces the stalk to the next joint above its insertion, before it expands; from thence to the point, it is three or four feet in length, according to the vigor of the plant. The leaf is farther divided by a nodosity which occurs at the distance of six or eight inches from the stalk, by which a contraction of the breadth of the leaf takes place, so as to form a channel for the water to descend to the joints. The leaves are situated, alternately, upon opposite sides of the stalk. The panicle of flowers is three or four feet long; and is composed of many spikes, nine or ten inches in length, which are again subdivided into smaller spikes. The seed is oblong and pointed, and ripens in the valves of the flower. In the cultivated state, the period required to attain maturity varies from twelve to twenty months.

Each cane joint, as in all the Grasses, presents a knot, or circular impression, from one quarter to one-third of an inch in width, whose surface is marked by little points, disposed in the quincunx order, and forming two or three rows. From these points originate roots, when the plant is laid down. Upon one side of the knot, a small scaly projection, somewhat swollen, and terminating at its upper extremity in an acute angle, is observed, which is the germ of a new plant. The knot of the next joint above or below, has its bud upon the opposite side. The rind of the Cane is formed of ligneous vessels, very closely arranged. The internal substance consists of undulatory vessels, whose arrangement is such, that they present horizontal layers, maintained at fixed and equal distances by sap vessels, the cavities of which are hexagonal, and, when the cane is mature, are filled with saccharine juice. Each sap vessel is divided into two parts, one taking the vertical direction, the other becoming horizontal; the latter is interlaced with the vertical vessels, and after having formed a thin stratum, they unite into a bundle, which pierces the rind, and constitutes the bud above described. The vessels which continue in a vertical direction, give to one side of the joint a convex, and to the other a concave surface, excepting at the knots, where the surface is convex on all sides.

The number of joints varies from forty, to sixty. They differ much in their dimensions, being short or long, large or small, straight or bulging. The foot of each stock is called the stole. It is formed of six or seven peculiar joints, having rows of little points at their surface, which are elements of roots. These joints are divided from each other by a leaf.

The Saccharum officinarum offers several varieties, which seem, in some cases, nearly adequate to form specific distinctions; although they are believed to have originated merely in differences of climate and cul-

ture. The most remarkable variety, or that which was first known to Europeans, is the Sugar Cane of Asia. It is called the Creole Cane. It flourishes, every where within the tropics, to an elevation of three thousand feet above the level of the sea; and in Mexico, it has been cultivated at nearly double this elevation. It affords more and better sugar as it approaches meridional latitudes, and places which are not too humid. A second variety is called the Otaheite Cane, from its having been brought to Antigua, and afterwards to the continent, from Otaheite. It is a taller and more powerful Cane than the Creole, having larger joints, and more pendant leaves. It arrives at maturity sooner, affords more sugar, and succeeds in soils which are too poor for the above variety. It thrives in colder climates than the Creole. The texture of its vessels is more ligneous, in consequence of which it offers greater resistance to the winds. In the West Indies, it is said to afford one-sixth more sugar than the Creole variety, besides having the advantage of yielding four crops in the same time required for three of the Creole. Its juice contains less mucilaginous and feculent matter, in consequence of which, it crystallizes more perfectly on evaporation, and affords a cleaner sugar. The third and last, principal variety is the Violet Cane, which has been erected into a species by M. de Tussac, in his Flora of the Antilles.* Its culm is purple; and in one variety, its leaves, also, are said to be purple. It prefers old land, and that which is rather dry. It flowers a month sooner than the other varieties; but gives a sugar less white, and affords more molasses.

Dutrone and Rumphius have mentioned several varieties less capable of distinction than those above enumerated; and which appear to have been produced from slighter diversities of soil and climate and within shorter periods of time.

The varieties of Cane cultivated in the United States, are the Creole, the Otaheite, and a third variety called the Ribbon Cane, which appears to be a hybrid between the Violet and the Otaheitan varieties.

## CULTURE OF THE SUGAR CANE IN LOUISIANA.

*Preparation of the Land.*—The sugar lands of Louisiana, from the low level at which they lie, are redeemed to agriculture by the ditches which are run back from the Mississippi, or the smaller streams upon which they are situated, into the contiguous swamps, which sink in level as they recede from the rivers, until they reach the Gulf of Mexico, or the lakes and bays which make inland from the Gulf. These ditches proceed back, at right angles to the river upon which the plantation lies, and extend in perfectly straight lines to a distance, from one to two miles, increasing in width and depth as they recede, until they finally inosculate with some natural drain, which receives, more or less perfectly, the waters they discharge, and carries them off to the sea. The natural drains owe their origin to the overflowing of the rivers, and to great rains—causes that were in operation previous to the construction of the ditches: they pursue an irregular course, whose general direction is a diagonal, between that of the river and the artificial drains. Their beds are broad, often enlarging into a kind of lake several hundred feet

* Tom. I. p. 160, fig. 25. Also M. M. Humboldt and Bonpland, Nov. Gener. et Speci. plan. tome I. p. 146.

across. In carrying back his straight ditches, the planter often intersects the heads of these little bayous which are thus dried up as he proceeds, and their broad and circuitous beds are redeemed for cultivation; while every part of the plantation is thereby rendered more dry and arable.

Very considerable differences, of course, exist on different estates, with respect to the intervals allowed between these ditches; and which arise in part out of the slope of the land in different districts. Two kinds of ditches are sometimes employed; one large, the other small, occurring alternately,—the larger being situated two acres apart. At their commencement near the river bank, or levy, they are narrower and more shallow; and they go on increasing in capacity as they run back. The large drains may be said to have an average width, at top, of five feet, and at bottom, of three, by two and a half in depth; while the narrow drains are two and a half, at top, and one and a half, at bottom, by one and a half deep. On the French plantations, the narrow drains are frequently omitted; the wider ones being situated two acres apart. Occasionally, a ditch is constructed nine or ten feet wide, at top, and proportionably deep. These ditches are carried into the swamps, a quarter, or half of a mile beyond the border of cultivation; and whenever the planter would bring more land under cultivation, the preliminary measure is, to extend his ditches farther into the swamp. Through the middle of the plantation runs a road from forty to sixty feet wide, with ditches on both sides; and when the plantation is wide, other parallel roads, of about half this width, are situated at distances of nearly a quarter of a mile. The sugar house and settlements are generally situated upon the main road. Cross roads, about four acres distant from each other, and twenty or twenty-five feet wide, with a shallow drain on one side or on both sides, divide the plantation into rectangular lots of four acres each. Across these lots in the centre, shallow drains are made with the plough; dividing the field again, so as to form two acre lots.

The land, thus divided off, is prepared for the Cane by being ploughed into furrows lengthwise of the plats, and harrowed; after which, it is drilled in the same direction, at distances varying between thirty inches and six feet, according to the newness and strength of the soil; when the canes are laid in the furrows, in pieces of from two and a half to four feet in length,—being so placed as to form two parallel rows in the furrow, three or four inches apart. The two rows of Cane in one furrow are not continued in all instances without breaks; but at least one row and a half is invariably maintained. They are covered with, from one to three inches of earth, according to the season of the year in which the planting is done.

*Planting.*—In describing this process, it will be most convenient to begin our account with the period when the canes are ripe. By the last of October, in ordinary seasons, more or less of the Cane attains its usual maturity for this climate. When this period arrives, the first thing to be done is to make provision for future crops. This early attention is given to the saving of seed on account of the injury occasioned to Seed Cane by frost, and which is liable to occur before the middle of November. The general rule observed in saving Cane for planting, is to reserve such a portion of the crop as is the least valuable for grinding. Accordingly, those fields which have produced Cane from the same stubble for two,

three, or four years, and which now require, from the stinted growth they produce, to be replanted with Cane or some other crop, are selected to furnish seed canes. The canes, or rattoons, as they are called from such fields, are small and short, having the joints more approximate, which is considered as an additional recommendation in their employment for planting, as every joint sends up cane shoots, and thus contributes to a fuller stand of Cane than when the joints are farther apart. One acre of such rattoons is sufficient, in ordinary cases, for the planting of three acres of land. They are cut near the ground, and carted to the vicinity of the fields where they are to be planted; being formed, when not planted as soon as cut, into long beds about fifteen feet wide, which are called *mattresses*. These are formed by commencing at one end of the bed, and placing a row of canes, with their tops on, across it—the tops directed outward. Upon this, a second row is superimposed, with this difference, that the buts are placed about eight inches or a foot in advance of those of the first row. Upon the second row a third is placed in like manner, and so on. By this arrangement the lower part of the stalk is preserved from the cold, by the tops; excepting in two or three layers across that portion of the mattress last formed, where the protection is effected by four or five inches of earth.

But a part of the planting is done with cane tops, or that portion of the Cane which is rejected in cutting it for the mill, and which consists of about three feet of the top of the stalk, to which the green leaves are attached at the time of gathering the crop. These, when not reserved for planting, are suffered to remain on the field, for the protection of the stubble; but when cut for planting, it is usual to cut them one or two joints lower than common, and to form them into wind-rows across the field,—the tops from two or four rows being thrown into one, which is arranged, as respects overlapping, after the manner of the mattresses above described. The fields from which the cane tops are derived for planting, are frequently those which were planted the previous year, and in which the cane is high, and somewhat prostrated at the commencement of the grinding season; in consequence of which, it requires to be cut the earlier, to prevent it from rooting at the lower joints.

The provision for a future crop, above described, is made earlier in the northern part of the cane district, where they are more exposed to the access of frost, early in the season.

When the extent of the force on a plantation will allow, the land is planted as fast as the seed cane is cut. The driest fields are selected for this early planting. It is thought to be attended with decided advantages—ensuring to the Cane more generally the life of the buds, than when in mattresses, and giving it an earlier start in the spring. Canes planted at this season, are covered to the depth of three or four inches.

The remainder, and indeed by far the greatest part of the planting, is deferred until the grinding season is over, which varies from the twentieth of December to the middle of January; and often, it is not completed before the first of March. The covering given to the canes is more and more shallow as the season advances, until towards the close of February, when it rarely exceeds two inches.

In relation to manures, and the distances at which they plant, these points are regulated by the newness of the lands. These are first brought in from the condition of swamp by carrying back the drains, with a

view to get rid of the water, as has been remarked above, and by cutting down the trees, and setting fire to the rubbish. The first crop is Indian corn, which is planted with hoes. It is picked early in autumn; and the Crab Grass, (Digitaria sanguinalis) which comes up abundantly on new land, is cut up with hoes, and stacked for winter feed. The land is now drilled for the first crop of Cane, by a plough, without a general ploughing,—the furrows being made from four and a half to six feet apart. The kind of Cane planted is Red Ribbon; because it is found to be the most hardy variety, and does better than either of the others in rich and wet lands,—the canes it affords the first year being fit to grind, and being used for seed. When lands have been worked for many years, the other varieties are employed, in various proportions, excepting in the northern sections of the cane district; where, from their liability to frost, the Red Ribbon is almost exclusively used on all kinds of land. After land has been once planted with Cane, the furrows are, ever after, made much nearer together,—the average distance being about three feet from centre to centre for Creole Cane, and four feet for Otaheite and Red Ribbon. The Red Ribbon rattoons are the best, the Creole are next, and the Otaheite are scarcely planted at all, excepting in the latitude of New Orleans, and there only for one year.

As a general statement, it is true that no manure is used; but the land, when tired of cane, which does not happen short of eight or ten years from the time of its being brought in from a wild state, is planted one or two years to Corn with Peas (beans), which perfectly restores it to full tilth for at least three years after. In general the ploughing is not deep; but when the culture is changed from Cane to Corn or Peas, the ploughing is deeper, in order to bring up a fresh soil, and to destroy the roots of the Cane.

*Culture.*—As soon as the black frosts are over, and the ground becomes sufficiently dry, the covering of the Cane that was planted in the autumn or early winter is reduced to one or two inches, by scraping with hoes the earth from the tops of the hills, towards the centres of the alleys between the rows. After this, the hoes, followed by the ploughs, are passed through the fields about every ten days, in order to keep down the Grass and weeds. When the cane has grown eighteen inches high, a small quantity of the earth is drawn back to the plants; and in the course of the two succeeding dressings, a bed is formed for them, five or six inches in depth. In new land, notwithstanding the weeds, much less hoeing is done, on account of the luxuriance of the Cane in such lands.

The stubble cane is, in some measure, protected from the frosts of winter by the covering of tops left on the rows in harvesting the cane. In the spring this is burnt off, and the portion of cane stalks which remains after the fire has run over the fields, is carried out into the roads. A plough is now passed along on each side of the stoles, turning the earth from them into the alleys. When the shoots have got up five or six inches, they commence restoring the earth to the stubble; and treat the fields in the manner described above for plant Cane.

A partial deviation from the above practice, with rattoon canes, has been adopted, to some extent, in the southern section of Louisiana. When the winter is mild, and the buds of the tops which are left in the field are generally alive, the tops are stripped of their leaves, and the stalks are laid down in a furrow made on the side of the stubble row. This is

done for the purpose of obtaining a fuller stand of Cane than the stubble alone would afford.

In consequence of the effects of frost upon the stubble, the rattoons of even the hardiest variety, the Red Ribbon Cane, are so deficient when suffered to rattoon a third year, that the practice is becoming extensive in the southern portion of the cane district, to plough up the fields after the second or third year of rattoons, and to replant with Cane, or to plant Peas, according to the strength of the land: while for the same reason, in the upper part of the cane district, it is considered a judicions system of planting on land which has been long in use, to put down one-third to plants, one-third to Corn and Peas, and to retain one-third in rattoons.

It is a part of the system of cane planting in Louisiana, to raise as full a stand of Cane upon the ground as possible,—experience having proved that more sugar is obtained from the land, than when it is so planted as to allow a free circulation of air among the plants. Neither the cutting up of suckers, nor the trashing of cane is practised.

The order in which the different varieties of Cane are injured by frost, is the following: the Creole suffers first, the Otaheite next, and the Red Ribbon least. In the cane district situated half a degree north of New Orleans, they suffer from frost nearly a fortnight earlier than in the lower section of the State. When the frost is very severe, they cut the Cane down as soon as possible, with the tops and leaves on, and suffer it to remain in contact with the ground until it is required by the kettles. The advantages of this course appear to depend upon the gradual change of temperature which ensues when frosted cane is placed in contact with the earth, and in its being liable to fewer fluctuations from heat and cold afterwards, when in this position.

Notwithstanding the susceptibility of the Creole and Otaheitan Canes to injury from frost, sugar planters in the vicinity of New Orleans, and farther south, plant at least one-third of their crop in these varieties. The inducement to have a part of the plantation in Otaheite Cane is, that if the season is a warm one, its yield is very great; while that for Creole arises out of its being suited to old lands, and if the frosts keep off, it affords a more beautiful variety of sugar than either of the other kinds, is handled with greater ease in harvesting, and costs much less fuel for the evaporation of its juice. It is agreed, however, that the Red Ribbon Cane is the variety which best suits the climate.

No complaint is as yet made of insects, in the cultivation of the Cane in Louisiana.

The carting of the canes, during harvesting, is attended with a heavier expense, and with more trouble than any operation in the growth of the Cane. The roads are often rendered excessively heavy and nearly impassable, from the rains that occur during the rolling or grinding season, which oblige the planter to maintain a great force of men and animals, to keep the kettles in operation. Besides, the driving over stubble cane, which might, however, be in some measure avoided, is productive of very considerable injury to the succeeding crop. It requires from ten to twenty carts to furnish canes for two sets of kettles, in proportion to the distance of the Cane from the mill, and the nature of the roads; an average number for the season may be sixteen. The manner in which the hands are distributed during the cutting season is the following, supposing the force adapted to a sugar house with two sets of kettles: forty hands, with knives, thirty-five to forty binders, or cart load-

ers, twelve to twenty cart boys, eight to supply the mill with Cane, (who are stationed at the mill), six kettle men, two stable boys, two boys at bagasse (ground cane) carts, three firemen, two to wheel wood to the furnaces.

The average yield of the Sugar Cane in Louisiana may be stated at one thousand pounds of sugar and forty-five gallons of molasses to the acre, taking one year with another. With tolerable plantership, it may be stated on lands well subdued at twelve hundred, and with superior attention, at fifteen hundred. In a few instances, when the seasons have proved favorable, we have heard of two thousand, and even twenty-five hundred pounds, or more, to the acre, on fields of small extent.

## IMPROVEMENTS SUGGESTED IN THE PLANTING OF CANE IN LOUISIANA.

The draining of the land, notwithstanding the importance attached to it in Louisiana, still merits from sugar planters generally, a higher de-degree of attention than it has received. It is only when the drains are sufficiently frequent and deep, and carried far back into the swamps, that the land can be delivered, with the requisite rapidity, of the water from rains, and the filtration which takes place through the banks of the river during the spring, when its level is above that of the land. Unless the land is capable of rapid drainage, it is impossible to deprive it of its coldness and clamminess; both of which are hostile to the early budding of the cane plants. During the summer, also, it is noticed that Cane on land well drained, endures the drought much better than on land imperfectly freed of its water; which may be owing to the reason that the surface of badly drained, clayey soils, is compact and hard—which condition prevents the communication of moisture from below upward, in that free and uniform manner that takes place when the upper stratum is more light and open. Besides, in the latter part of the season, the standing of water in the cane fields tends, in no inconsiderable degree, to weaken the strength of the juice. Imperfect draining also enhances the labor of harvesting.

The value of animal manure, duly mingled with decayed vegetable matter, has not hitherto been duly appreciated. There are few considerable estates where fewer than one hundred head of cattle, including horses and mules, are kept; and yet the economical arrangement of *cattle pens*, where the bagasse and other vegetable matter might be formed into manure, is unknown. This is the more surprising, since in a clayey, impalpable soil, like that of Louisiana, nothing can be of higher importance than the addition of light, imperfectly comminuted, vegetable matter. Ashes and shells would also prove beneficial to the land; although the effects of the latter would be less apparent. The operation of these amendments would obviously be, to keep the soil open and free for the admission of air, and the due evaporation of moisture,—conditions of the first importance to the rooting of the plants, and consequently to the growth and maturity of the crop.

The preference so generally expressed for early planting would appear to be extremely well founded in theory; inasmuch as the ground in the autumn is in fine condition for the shooting of the roots, which, when once thrown out, prepare the plant for an early start in the spring. Besides, upon this plan, much time is saved, which, in the ordinary way, is consumed in forming mattresses, and in the repeated handling of the cane.

In vindication of the mode of thick planting, however, nothing but experience appears capable of being urged; and whether it is clearly established on this basis admits of a doubt. It appears reasonable to expect that the rich soil of the Mississippi will afford a greater weight of Cane from the adoption of this system; and that the amount of sugar may be as great, or even greater, may also be true; but that the quantity of water to be evaporated must be abundantly greater in proportion to the weight of the Cane, and consequently the labor of harvesting be greatly augmented, would appear equally obvious. When a great number of shoots are encouraged in their growth from a small space of ground, they are of course hindered from spreading their leaves at bottom, they draw each other up to a great height, and are filled with watery juice,—the sun and external air being excluded from the stalks, both of which are necesary to ripen and elaborate the sugar during the growth of the canes.

We should be strongly disposed to adopt a system of wider planting: say, in well cultivated lands, five feet apart for the furrows, to lay the canes in the drill in single rows, to prevent them from suckering by the use of the knife, and in this manner to reduce the number of stalks upon a given piece of ground, from one-third to one half. By thus giving free access to the sun and air, we should expect that the canes would afford a vastly greater yield of sugar; that they would arrive much sooner at maturity; and that the evaporation of the juice would be attended with a great saving of labor and fuel. This method appears at least worthy of trial for a part of the crop; and especially on those estates not infested with the nut-grass (Cyperus hydra). Fields, planted according to this method, might not withstand so successfully the effects of a severe frost, as those on the common plan; and might require more hoeing and ploughing to keep down grass and weeds, as these also thrive in proportion to light and heat. But a large part of the crop is secured before the access of injurious frosts; and if by adopting this method, the Cane could be made to attain an earlier maturity, it might be possible to complete the grinding, more frequently than is at present practicable, without exposure to an accident from this source. A cane field planted in the open manner alluded to, would be in no greater danger from winds than one more thickly planted, inasmuch as the rooting of the canes would be stronger, and the stalks themselves would possess more strength, and thus enable them the more effectually to offer resistance to storms.

Although the most successful sugar planters testify in favor of planting with rattoon canes, and not with succulent plant canes and tops, still the latter practice is very general. To say the least, this system is not countenanced by experience in other branches of agriculture; for it is well known, that it is by carefully propagating all kinds of esculent plants, either in the choice of the best seeds or cuttings, that most of the species have been so greatly improved. By planting the lower part of well ripened canes, less luxuriant shoots would no doubt be obtained; but their juice would be less crude, and more rich in saccharine matter, while, at the same time, the sugar would be obtained by less boiling than that of the canes, reared in the manner in which they are commonly planted.

In ploughing the land for planting, it is important to turn up the surface completely, unless it be in new land; the practice of merely running a

furrow between the old rows, is liable to be attended with the loss of many canes, from the flowing in of water, which rots the plants.

When it is impossible to plant land in the autumn, it is attended with a decided advantage to plough up the soil as early as possible, in order that it may remain exposed to the effects of frost and rains, till the planting can be done.

In ploughing the cane fields at the season of hoeing, it is advisable not to plough deep, especially for the last hoeing, or *hilling*, as it is called; for there is great danger of disturbing the roots, which, by the time the Cane is twenty or twenty-four inches high, extend far into the alleys.

Against the practice of cutting down the Cane when killed by frost, to preserve it the longer for grinding, no objection can be urged; it should not be resorted to, however, prematurely; for if cut down when green, its buds will be liable to swell; but if the top leaves are killed, and the uppermost buds injured, it will still be prudent to let it stand for several days, until vegetation is seen to be entirely checked in the lower joints, after which it may be cut.

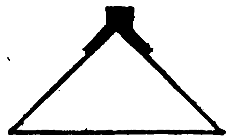
It is strongly to be hoped that some variety of the Sugar Cane will yet be produced, that shall suit the exigencies of the climate. That either of the present varieties will fully answer the requisition, is at least doubtful. Numerous observations go to prove, that each variety of plants, in consequence of a structure which no artificial treatment can affect, is capable of supporting only a limited temperature. De Candolle does not allow that plants coming from seed produced in countries into which the plants have been introduced, are more hardy than those derived from seeds brought from the country in which they are indigenous. But it is a well known fact, that culture gives rise to varieties which never did, and never can exist, in a state of nature; and which possess, in the structure of their tissues, unequal degrees of susceptibility to temperature. Such varieties, are all hybrids of other varieties. In this way, Potatoes have been obtained, whose entire vegetation occupies only three months; and Olives, which sustain a severer cold than those of France. The artificial culture in the United States, of all the varieties of the Cane, is, therefore, deserving of the greatest attention; and if judiciously persevered in, holds out ample encouragement that varieties will eventually be produced, perfectly adapted to the climate of the Southern States.

The preservation of Cane in mattresses is attended with little difficulty, provided the precaution be taken of placing the canes flat on the ground, which should be scraped smooth for their reception,—laying the buts of the Canes as nearly as possible to the north-west, in order to prevent the cold wind from that quarter from penetrating the bed. It has been found useful, also, to make the bed as flat as possible, that each cane may be nearly in contact with the earth.

In planting the canes, care should be taken to lay the eyes toward the sides of the drills; and to avoid placing them so that the eyes shall be alternately up and down. This attention will demand more time, but it will ensure the canes being placed at proper distances from each other, and greatly promote the shooting of the eyes; since, when the canes are not placed in the way here recommended, those buds which are uppermost, occasionally perish from frost, while those underneath have an unnecessary resistance to encounter in shooting downwards,

and curving round to gain the upright position, in effecting which, a very slight obstacle causes them to fail altogether.

In concluding this part of the subject, it may not be unsuitable to introduce a few remarks upon the transportation of Cane to the mill. The carting of Cane with oxen, horses and mules in the ordinary way, is felt to be the most severe and onerous operation of the cane crop, on account of the great bulk and weight of the canes and the heaviness of the roads during the rains. With a view to remedy this inconvenience, Madame Poeyferré has, at the recommendation of Mr. Edmond Forstall, caused a permanent rail to be laid down through the centre of her plantation,—the land on each side being 3½ acres wide. The iron rails are in 12 feet pieces, each weighing 56 pounds. They are fitted to the most obtuse angle of timbers formed from sawing, diagonally, 6 inch cypress scantling. The annexed Figure represents a cross section of the rail and the timber. This rail is to be furnished with 6 acres of moveable rail;—the iron projecting beyond the wood at one end of the 12 foot pieces and the wood at the other, so that when laid down, the iron rails meet: its use will be to bring in the canes from either side, to the permanent rail. Forty-two arpents of the permanent rail were in operation the last season; the convenience of which, not only in bringing in the Cane, but also in delivering the wood from the swamp at the sugar house, was found to be very great. It cost $100 per arpent. The expense of the moveable rail will not exceed $70 the arpent.



This is, unquestionably, a capital improvement in the management of Sugar Estates in Louisiana; but it is highly deserving of attention, whether a cheaper construction, would not equally answer the purpose. Mr. J. H. Cowper, of Georgia, employs a moveable rail, wholly constructed of wood; of which he is able to lay down more than a mile and a half. The cross pieces are 4 feet apart, over which the horses, in drawing the cars, soon learn to step, without the least embarrassment. He informs us that its cost is not above $100 the mile.

## CULTURE OF THE SUGAR CANE IN GEORGIA AND EAST FLORIDA.

The difference in the culture of the Cane between these regions and Louisiana, arises chiefly out of soil. The lands upon which the Cane is here cultivated are either *tide swamp, inland swamp,* or *hammocks.* The tide swamp land is situated directly upon rivers, and is drained by the construction of a bank, or levy, and the excavation of a large canal, through the centre of any considerable tract, say from 400 to 1000 acres, which often runs back a mile or more from the river. The canal is connected with the river by lock gates adapted to the passing of flat boats at the highest stages of the tide, and it serves also for the draining of the land situated far back from the river. Other considerable ditches also occur at various distances, upon a plantation of swamp-tide land, each having its gate for communication with the river. So low and flat are these lands, that they are capable of being laid under water, at particular stages of every tide, which eminently fits them for the rice culture to which they are chiefly devoted. They are, however, to some

extent, devoted to the Cane, which is planted in rotation with cotton and rice. The inland swamp constitutes tracts from 100 to several thousand acres, situated at low levels, completely environed with pine lands, excepting an outlet to some river or small stream. It is drained with considerable difficulty, by deepening the outlet and intersecting the swamp with ditches. The third class of cane land is formed by what are called *hammocks*. These are situated between the swamp and the pine lands, forming belts or borders of various degrees of thickness, and characterized by the natural growth of large evergreen oaks, hickory, red bay, magnolia, and cabbage-palmetto. The soil is, in some measure, intermediate between that of the swamp and pine lands, but nevertheless abounds with a dark vegetable mould.

The mode of planting in this region differs somewhat from that of Louisiana; inasmuch as the softness of the swamp land prevents the free use of the plough: the hoe is therefore, of necessity, more extensively employed in the working of such land. The canes, are, moreover, planted in rows wider apart, and the cuttings are less numerous in the row. But a difference still more remarkable arises out of the use of manures. Vegetable and animal manures are introduced so as to form beds, after the manner adopted in cotton planting, the canes being planted in a drill upon the top of the beds. They construct their mattresses of seed Cane also in a manner different from the Louisiana planters. The Cane is thrown into windrows in the alleys, two rows forming a windrow, where, after wilting for two or three days, it is covered four or five inches deep with dirt.

The failure of rattoons in Georgia is very common; in consequence of which, they are rarely suffered to run above one year; and on rice land, where the Cane is employed for the purpose of procuring a rotation of crops, it is rarely suffered to rattoon at all. The Red Ribbon variety is in the most extensive use; although in Florida they employ the Creole and Otaheite to the same or even greater extent than it is used in Louisiana.

## REMARKS AND SUGGESTIONS IN RELATION TO CANE PLANTING IN GEORGIA AND EAST FLORIDA.

In advancing suggestions for the benefit of the Sugar planters of this district, perhaps nothing, so well worthy of consideration, can be presented as the remarks of Mr. James H. Cowper, of Hopeton, whose scientific attainments and experience in planting, eminently qualify him for treating the subject. In an unpublished memoir, from which he obligingly permitted us to make extracts, he says, "It is believed that the Cane can be cultivated, profitably, on the sea board of Georgia, in rich lands which can be well drained. To ensure success, such an apparatus must be procured, and such facilities for harvesting provided, as to take off the crop between the 1st of November and the 15th of December. It will be unsafe to calculate on a longer grinding season. To enable the planter to accomplish this, he should not plant more than half his crop in Cane. This will enable him to apply a double force to the harvesting of the cane crop, prevent his land being exhausted by the continual succession of the same crop, and facilitate all his operations during the year.

"Under the circumstances above mentioned, it is believed that the

cane crop will, on an average of several years, be more profitable than either cotton or rice: but enormous profits are not to be expected from it in this climate. The chief value is, in offering a third plant yielding a rich return, to be combined with rice and cotton; thus extending the system of rotation another year.

"The cane crop, being in a great measure exempt from the fatal effects of fall gales, gives a very desirable security to the planter against a total loss of crops, should they occur.

"The investment of capital in machinery is not greater for Cane than for rice, when the latter is pounded on the plantation: it is however far greater than for cotton; and this circumstance should operate against any attempt to enter into the cultivation of the Cane except on a scale of 100 to 200 acres, and under the advantages of rich soil and efficient drainage. If undertaken on a small scale, without sufficient machinery and without adequate preparation for transportation, failure may be expected as the certain result, and accompanied with a great waste and expenditure of labor."

It is deserving of trial whether rattoons of two years cannot be made to grow in Georgia with the same advantage as in Louisiana, by observing the precaution to run a furrow in autumn along upon the side of the rows so as to bury the buds which are nearest to the surface, and in this way to defend them from the severest frosts, by which they seem more liable to receive injury, on account of the lightness of the soils.

In preparing inland swamps for the Cane, complaint is often made of the acidity or sourness of the land,—a condition which depends upon the incomplete decomposition of the vegetable matter it contains. The most speedy remedy for such soil consists in opening it to the sun, by effectual ditching and burning, and by the addition of a dressing of ashes, or of quicklime.

We shall add still farther, from the directions of Mr. Cowper. "If the field has been planted the previous year in Cotton, the cotton beds are shaved down into the alleys, covering the trash, &c. and forming a wide list. In performing this operation, care must be taken that the earth over the vegetable list is sufficiently deep to afford a moist and close foundation, for the Cane planted, may otherwise from a deficiency of moisture, or the access of the air, take the dry rot.

"The canes should be cut in short pieces, so as never to exceed 3½ feet, as the buds which come forward first, monopolize the whole sap." "Another reason for planting the Cane in short pieces is, that, sometimes, from the action of moisture and heat, the canes bend, if in long pieces, and the extremeties are lifted out of the ground, and so prevented from budding."

Mr. C. says that plants should not be covered above 1 or 1½ inches, and that the closeness is more important than the depth of the covering. On friable, clay lands, he has found half an inch sufficiently deep, even in the coldest winter. The prevalent error, he believes to be, in covering too deep. When the soil is wet and the planting is deep, they are very liable to rot. His four requisites, in planting, are the following: 1. Have the soil well drained and in fine tilth; 2. Sound seed; 3. Light but careful covering, closely pressed to the canes; 4. Placing the canes an inch or two below the level of the land, so as to insure the lower sides being in close contact with a moist but not wet soil. Mr. C. says, the earlier the operation of planting is performed, the better, as the canes are safe

when planted; they are slowly throwing out roots during winter to support the shoots in the spring,—the soil is more moist, and therefore better adapted to receive the plants in winter than in spring, and the buds being then undeveloped, there is no risk of breaking off the shoots of which there will be danger, if the planting is postponed until spring.

Of the comparative value of the different kinds of lands in Georgia and East Florida for the Cane, it may be remarked, that the hammock lands are the best. They are lighter, warmer and drier, and afford to the Cane a much more perfect maturity. The sugar they yield is superior to any produced in the United States, and approaches very closely to the best samples from the West Indies. That from inland swamps, and tide swamps is softer grained, and frees itself less perfectly from molasses, of which it affords a much greater proportionate yield.

One of the earliest cultivators of sugar in this part of the United States, Mr. Thomas Spalding of Sapello Island, who, upon the subject under consideration, has communicated a number of highly interesting articles to the southern agriculturists, remarking upon this point, in one of his papers, says:—"The alluvion soils of the river, or the lower grounds upon creeks will, no doubt, produce a much superior growth of Cane; from which, however, it is more difficult to make the sugar, and the sugar of which is always inferior. Every day's experience satisfies me that lighter soils will in the end be more profitable, while they are certainly cultivated with less labor to men and animals, than those of a heavier quality. If, however, river lands, or low lands of any description are selected, upon such I would unquestionably plant the Ribbon Cane; because on these soils, the juices are more abundant, than upon lighter lands, which removes one of the material objections to this Cane; and its ripening in the month of October, enables the cultivator to get off a great portion of his crop."

## CHEMICAL HISTORY OF CANE JUICE.

When the Cane has arrived at maturity, its juice contains, besides the water of solution, sugar, gum, vegetable mucilage, albumen, gluten, green fecula (or green coloring matter,) and lignin; to which may be added several free acids and salts, which, however, exist only in minute proportions, without exercising any appreciable influence over the process of obtaining the sugar in a separate state. The properties of these ingredients require a separate elucidation: this we shall attempt, in the first place, under the idea of their existence in an insulated condition, or in a state of purity, and afterwards as they present themselves united in the cane liquor.

1. *Sugar.*—This substance when in loaf, consists of an aggregate of little crystalline grains, is white, inodorous and of a well known sweet taste.

It is hard, brittle, and emits a phosphorescent light, when two pieces are rubbed together in the dark. Its specific gravity is 1.6065.

When a saturated solution of it, in water, is left to spontaneous evaporation, in a warm place, it crystallizes in very perfect oblique rhombic prisms, whose acute lateral edges are often truncated, and whose summits are terminated by two or more planes. These crystals are transparent; and although heated to the point of fusion, they lose no weight.

Stove-dried loaf sugar is also anhydrous or destitute of water; and appears to be unalterable in the air. It becomes fluid at a heat some-

what below 300° of F.: when the heat is raised above 302° of F., decomposition commences, attended with a peculiar odor, called by the French, *caramel.* At a temperature, a little below ignition, it bursts into a flame, affording the usual products of the destructive distillation of vegetable matter.

Sugar is soluble in water in nearly all proportions. When dissolved in one third of its weight of that fluid, it forms a syrup which keeps well in close vessels; but if more highly diluted with water, it rapidly changes, particularly if in contact with air,—becoming sour and mouldy. The addition of certain vegetable, or vegeto-animal substances, such as albumen and gluten, or of yeast, produces a reaction among its constituent elements, which gives rise to the vinous fermentation,—a process in which the Sugar is converted into carbonic acid and alcohol, the former of which is disengaged with effervescence, while the latter remains, in a great measure, in the liquid.

Sugar is soluble in about four times its weight of boiling alcohol of the specific purity 0.83, which, on cooling, deposits the greater part of the Sugar; but it is probably insoluble in absolute or pure alcohol.

It is altered by the action of acids. Concentrated sulphuric acid, poured upon it, becomes blackened, and on being diluted with water, a carbonaceous precipitate ensues. The effect of nitric acid on Sugar, is to transform it into malic and oxalic acid. Oxalic or tartaric acid, added in the proportion of three per cent. to Sugar, destroys its power of crystallization, nor is it restored when these acids are saturated by carbonate of lime or carbonate of lead.

Sugar enters into chemical combination with the salifiable bases. Dissolved in a ley of potash, it loses its sweet taste and gives, after evaporation, a mass which is insoluble in alcohol; but on the addition of the requisite quantity of some acid to engage the alkali, the Sugar re-appears in the solution, possessed of its original properties. When introduced, in the condition of a fine powder, into a bell glass of ammonical gas, over a mercurial bath, the gas is gradually absorbed, while the Sugar becomes compact and soft, to such a degree as to allow of being sliced with a knife. It emits the odor of ammonia. Analysis proves it to consist of 90.28 parts of Sugar, 4.72 of ammonia and 5.00 of water. In the air, this compound undergoes a spontaneous decomposition.

Dissolved in water, Sugar combines with the hydrates of the alkaline earths, forming with them an uncrystallizable mass of a slightly sugary odor, and a bitter astringent taste. When a solution of such a compound is evaporated, it becomes viscid and at length hardens into a yellow, gummy mass,—exhibiting, when broken, a conchoidal fracture.

According to the experiments of Daniel, Sugar dissolves about one half its weight of lime. Having boiled together, for half an hour, 1,000 parts of Sugar, 600 of quicklime and 1,500 of water, and having examined the liquor, after its cooling, he found that it contained in 100 parts, 16.5 of lime and 83.2 of Sugar, and that in evaporating it slowly, it assumed a solid consistence with the aspect of gum, in which, when the compound was freshly decomposed, the Sugar manifested its original properties; but, on being left for several months in a moist condition, the lime separated itself in the state of corbonate of lime, crystallized in very acute rhomboids, while the Sugar was transformed into a mucilaginous gum.

Sugar, according to Berzelius, forms with oxide of lead two combinations, of which one is soluble, the other insoluble. By digesting a solution of Sugar with a certain quantity of oxide of lead, a liquid solution is obtained, which has the re-action of alkalis, and leaves, after evaporation, an uncrystallized, viscid mass, which attracts moisture from the atmosphere. When a solution of Sugar, boiled with an excess of oxide of lead is filtered and corked up from the air in a vial, it deposits after 24 hours standing, a voluminous, white precipitate, which on being separated and dried, is destitute of taste, and insoluble in cold and boiling water. Its drying requires to be effected *in vacuo*, in order to avoid decomposition. It burns like tinder, when a mass of it is lighted at one extremity,—leaving behind numerous little globules of metallic lead. It is soluble in the acids, and likewise in the neutral acetate of lead, which forms with the oxide of lead a sub salt, and sets the Sugar at liberty. Its powder, mechanically suspended in water, is decomposed by a current of carbonic acid gas, passed through that liquid,—the Sugar making its appearance in the solution, while the carbonate of lead falls to the bottom. This compound of Sugar and oxide of lead is insoluble in alcohol. By analysis, it affords 58.26 oxide of lead and 41.74 Sugar.

Sugar does not combine with any salt, although it decomposes several metallic salts. It has the remarkable property of dissolving the carbonate and the sub-acetate of copper, and of thus giving rise to a green liquid, from which the oxide of copper is not precipitated by alkalis, but by ferro-cyanuret of potash and by sulphuretted hydrogen. Dr. Ure is of opinion that no re-agent is capable of precipitating the copper from the solution of sub-acetate of copper in Sugar. Sugar, boiled with solutions of the salts of copper is known to act upon them by effecting their reduction. When the sulphate of copper is thus treated, metallic copper is precipitated, a part of the cupreous salt remains in solution, and there is thrown down with the metal a brown substance soluble in ammonia. The nitrate of copper submitted to the same treatment, gives no precipitate, but it is transformed into a cupreous salt, and potash forms in the solution, a yellow precipitate of hydrate of copper. Sugar, boiled with the acetate of copper, occasions a copious precipitation of the oxide of copper.

By the aid of ebullition, Sugar, added to a solution of nitrate of silver, affords a pulverulent, black precipitate whose composition is unknown.

The chloride of gold gives a pulverulent red precipitate. When Sugar is added to a solution of a salt of iron, the oxide of iron is not wholly precipitated by ammonia.

The analysis of perfectly anhydrous Sugar has been made only by Berzelius. In burning the compound of Sugar and oxide of lead, he obtained from 100 parts of Sugar 57.5 to 57.75 parts of water, and 16.25 to 16.3 of carbonic acid, which leads to the following conclusion as to the composition of Sugar:

| | |
|---|---|
| Carbon - - - - | 44.99 |
| Hydrogen - - - - | 6.41 |
| Oxygen - - - - | 48.60 |

Common Sugar, or Sugar not perfectly anhydrous, has also been sub-

jected to analysis by Berzelius, as well as by other chemists, the results of whose labors are as follows :

| | *Prout.* | *Gay, Lussac & Thénard.* | *Berzelius.* |
|---|---|---|---|
| Carbon | 42.85 | 42.47 | 42.225 |
| Hydrogen | 6.44 | 6.90 | 6.600 |
| Oxygen | 50.71 | 50.63 | 51.175 |

2. *Gum.* This is a transparent, colorless substance. It is uncrystallizable, occurring in the form of small globular masses. The fracture is conchoidal, with a vitreous lustre, and a specific gravity of between 1.31 and 1.48. It is destitute of lustre or odor.

It contains no water; but when an aqueous solution of it is gradually evaporated, the gum retains, even when perfectly dry, about 17 per cent. of water, which it gives up on exposure to a heat of 100° *in vacuo.*

It is slowly, but completely dissolved in water in every proportion, and more readily in warm than in cold water.

The solution is mucilaginous, tasteless and inodorous: its viscidity presenting very minutely divided matter suspended in it, from being deposited. If, for example, a metallic salt, as acetate of lead, be added to a solution of gum, and a current of sulphuretted hydrogen be passed through the resulting fluid, the sulphur will not be precipitated, but will remain mechanically suspended in the solution.

For the same reason, gum hinders Sugar and the soluble salts from crystallizing.

Left to itself, a solution of gum gradually becomes acid,—exhaling an odor like acetic acid.

Gum is soluble in alcohol and in ether.

Alcohol precipitates it, although imperfectly, from its solution—the precipitated liquid remaining, for a long time, milky.

Gum is equally soluble in acids or in water,—the concentrated acids altering its composition. Strong sulphuric acid decomposes it,—causing the formation of water and acetic acid, with a deposition of charcoal. Nitric acid, aided by a mild heat, occasions the evolution of nitric oxide gas, and on cooling, the liquor deposits mucic acid in the proportion of from 0.14 to 0.25 times its weight of the gum. By a protracted digestion, malic and oxalic acids are obtained.

Gum forms definite compounds, with salifiable bases. If a concentrated solution of gum be mingled with a solution of potash, a coagulated precipitate makes its appearance,—consisting of gum and alkali, which afterwards dissolves. When alcohol is added to the solution of this compound, which contains an excess of alkali, the combination of gum and alkali is precipitated, while the excess of the potash remains in solution. The precipitate is of a curdy nature, which when dried is easily reduced to powder, and may be again dissolved in water.

Gum unites with the oxide of lead, when a solution of the former is digested with the latter, and the union is promoted by levigation. The compound is insoluble. It may be obtained also by mingling a solution of gum with the sub-acetate, or sub nitrate of lead. The mass is curdy. After washing and drying, it is white, and easily reduced to powder. It consists of 61.75 gum and 38.25 oxide of lead. Exposed

to the action of heat, gum is decomposed, giving rise to the same products and phenomena as other vegetable matter: i. e. to acid water, empyreumatic oil, carbonic acid gas, carburetted hydrogen gas and a spongy charcoal. When heated, it yields also a small quantity of ammonia, which is believed to be owing to some impurity, probably gluten, with which it is generally associated. The following are the results obtained from the analyses of gum arabic, 1 by Gay Lussac and Thenard, and 2 by Berzelius:

| | 1. | 2. |
|---|---|---|
| Hydrogen, - - | 6.93 | 6.374 |
| Carbon, - - - | 42.23 | 42.682 |
| Oxygen, - - - | 50.84 | 50.944 |

3. *Vegetable mucilage.* This proximate principle of plants presents itself under the form of a jelly, more or less translucent, which, when diluted with a large quantity of water and thoroughly blended with it, becomes so attenuated, as to pass through paper like a viscid liquid, every drop drawing after it a thread, whose upper portion, when it breaks, rises to the paper. In this condition, the mucilage appears to approach to the state of a solution: but on employing a smaller quantity of water, it is seen to be only a mere swelling of the mucilage which takes place, as appears from the fact that the mass, on being thrown upon blotting paper, communicates to it none of its mucilaginous properties.

After drying, the mucilage forms a hard mass, translucent, white, or yellowish, without taste or odor, and which swells up, and becomes a second time buoyant on water.

Like gum, it affords the smell of ammonia by distillation, but it is not known whether it contains nitrogen, or whether this element comes from some foreign matter with which it may be associated.

The alkalies and acids dissolve, and destroy its mucocity, converting it into a matter analagous to gum. When subjected to a boiling temperature in a large quantity of water, the same change is said to take place.

It is not improbable that mucilage is only a modification of gum, or possibly an incipient gum.

4. *Gluten* is possessed of the following properties: when dry, it is of a pale yellow color, translucent, hard and brittle; when moist, it adheres tenaciously to the fingers, and has considerable elasticity. It is without smell or taste.

It is ordinarily slightly acid, owing to the acids with which it is combined, as the acetic and phosphoric.

It is insoluble in water and ether, but dissolves readily in hot alcohol, apparently without any change of properties: but if the alcoholic solution is evaporated to dryness, the gluten is left as a transparent varnish.

It swells up and softens with acetic acid, forming a compound which is soluble in water and precipitable by nut galls. It unites also with the mineral acids; and these compounds, excepting that with sulphuric acid, dissolve readily in pure water, but are insoluble when there is an excess of acid. It is dissolved by a dilute solution of potash, apparently without being decomposed; for the gluten after having been thrown

down by the mineral acids, retains its viscidity. In this state, however, it is combined with some of the acid. Ammonia and lime exert but little action upon gluten, when in the solid form; but when to a solution of gluten in an acid, caustic ammonia, or lime is poured, drop by drop, a precipitate is formed which quickly disappears.

The combinations of gluten with the other bases are all insoluble in water, and are precipitated when a solution of the compound of potash and gluten is mixed with the earthy or metalic salts.

The alkaline carbonates do not dissolve gluten immediately. They precipitate it from its solution in the acids, and the more completely according as a greater quantity of the precipitate is added, and as the solution is more concentrated. The chloride of mercury forms an abundant white precipitate in acid or alkaline solutions saturated with gluten. In this case, the gluten combines with one portion of the salt, after the manner of many animal substances. Exposed to a strong heat, gluten yields, in addition to the usual inflammable gases, a thick fetid oil and corbonate of ammonia.

5. *Albumen.* This substance exists in all vegetables whose sap coagulates by heat. It is soluble in water, until it has been inspissated by heating, which renders it completely insoluble. On being dried, it becomes opake, and assumes a white, grey, brown or black color.

It is insoluble in alcohol. The caustic alkalies dissolve it readily; it neutralizes their caustic taste, and is precipitated from its union with them, on the addition of an acid in great excess.

The solution of albumen may be rendered so acid as to redden the paper of turnsole without occasioning any precipitate, the liquid simply becoming milky, and reassuming its transparency on being heated. By a very considerable excess of acid, however, the vegetable albumen is thrown down; and the precipitate is a chemical combination of albumen with the acid which is scarcely soluble in the acid liquor, but soluble in pure water.

The latter solution is easily precipitated by the acids, ferro-cyanate of potash, chloride of mercury and nut galls. When a solution of the potash completely saturated with albumen is mingled with a solution of any metallic or earthy salt, corresponding compounds of albumen with the bases are obtained. These compounds are nearly all insoluble.

Vegetable albumen is not dissolved by the alkaline carbonates, and after having been coagulated, it ceases to be soluble in caustic ammonia. If carbonate of ammonia is added to a saturated solution of albumen in potash, a part of the albumen is precipitated, but the precipitate is redissolved in a large quantity of water. Carbonate of ammonia precipitates it from its solution in the acids, better than any other reagent; nevertheless it retains a certain portion of it.

Albumen and gluten, in consequence of their great resemblance to the white of an egg, and to the fibrin of animal fluids, have received the common name of vegeto-animal substances. They contain not only nitrogen, as is evinced by the evolution of ammonia from their destructive distillation, but they often contain sulphur and phosphorus. When left to themselves in the humid state, they undergo the putrid decomposition, attended by the disgusting odor of animal putrefaction, the disengagement of ammonia and the production of acetate of ammonia.

At a certain stage of their decomposition, both when united and when separate, they afford the odor of old cheese.

Gluten and Albumen, when aided by water and heat, exert jointly, and perhaps separately, a very remarkable action upon starch. Two parts of potato starch are mixed with four of cold water, gradually diluted with 20 parts of boiling water and blended with one part of dried and powdered gluten and albumen; the composition is exposed, during 8 hours, to a temperature of between 50 and 70° C. After about 2 hours, it loses its consistence, and the reaction takes place rapidly, so that the liquor becomes very fluid, transparent and sugary. One part of the starch is transformed into gum, and another into sugar; the mixture not absorbing either of the gases of the air, but emitting a small quantity of carbonic acid gas.

According to Saussure, cold diluted alcohol, added to the mixture in a dry state, dissolves a quantity of Sugar, equal to 1-7th of the starch employed, and water removes from the residue a quantity of gum equal to one-fifth of the starch. The remainder consists of a mixture of starch not altered, and of gluten which is acid, and has lost almost totally the property of reacting on the starch.

6. *Green Fecula.* This is the Herbaceous matter of Dr. Higgins. It is the coloring matter of the leaves and stalk. Its prevailing hue is green, although other colors, as red and yellow, enter into its composition. It is precipitated from the sap of plants by lime water, barytes and strontian, and by the salts of these bases. The precipitates are of a yellowish green color and insoluble in water. The coloring matter is closely associated with a waxy or resinous substance, from which it has never been perfectly freed. The compound is bleached by exposure to the sun and by chlorine. The acids also destroy its color. Caustic potash converts it into soap. It is soluble in alcohol and ether, and in fixed and volatile oils. When plants approach the period in which their fruit become perfect, the waxy matter assumes a yellowish color.

7. *Lignin* constitutes the porous tissue by which the sap of plants is conducted from the root to the branches. It constitutes the skeleton of vegetables; and is what remains after a plant or a part of a plant has been treated with ether, alcohol, water, dilute acids and alkalies. Owing to its porous texture as well as its chemical affinity for coloring matter it is frequently stained of some color; especially in the dead plant. Concentrated sulphuric acid converts it into gum; and nitric acid, into oxalic acid. The concentrated solutions of alkalies dissolve it into a homogeneous mass, having an empyreumatic odor and a blackish color, and containing acetic and oxalic acids.

### *Free Acids and Salts in Cane Liquor.*

As these exist in cane liquor in almost inappreciable proportions, and do not exert a perceptible influence upon the process of separating the Sugar, it will not be necessary to enter into a minute detail of their properties. The acids are two in number; the acetic and malic.

(*a.*) *Acetic acid* is distinguished from all other acids by its smell and flavor. Its acidity is well marked, as it reddens litmus paper powerfully, and forms neutral salts with the alkaline and earthy and metallic

bases. It is exceedingly volatile, rising rapidly in vapor at a moderate temperature, without undergoing any change. Its vapor is inflammable, burning with a white light. In its most concentrated form, and under a temperature of 50° F., it crystallizes. It consists of 52.95 oxygen and hydrogen, in the proportion to form water, and 47.05 carbon. The salts of acetic acid are called acetates. They are all soluble in water, the solutions being liable to a spontaneous decomposition when exposed to the air. They are eminently deliquescent and are destroyed by a high temperature.

(b.) *Malic acid* has a very pleasant acid taste. It crystallizes with great difficulty, and in an imperfect manner, attracting moisture from the atmosphere, and is very soluble in water and alcohol. Its aqueous solution is gradually decomposed by keeping. Nitric acid converts it into oxalic acid. Most of the salts of malic acid are more or less soluble in water. The malates of soda and potash are very deliquescent.

The salts in cane liquor are the following: 1. Acetate of lime, 2. Acetate of potash, 3. Super malate of lime, 4. Sulphate of lime.

1. *Acetate of lime* crystallizes in silky fibres, is very soluble and possessed of a sharp bitter taste; its solution, when exposed to the air, undergoes a spontaneous decomposition, the lime being converted into carbonate of lime and the acetic acid set at liberty, in the solution.

2. *Acetate of potash*, when cautiously evaporated, forms irregular crystals, which are obtained with difficulty, owing to the deliquescence of the salt. Its solution, even in closely stopped vials, is spontaneously decomposed.

3. *Super malate of lime* is very soluble in water, but insoluble in alcohol. When the solution is evaporated, it appears under the form of a yellowish, or brownish gum.

4. *Sulphate of lime*, as obtained from plants, is in the condition of an impalpable white powder. It requires 461 7-13 parts of cold water for its solution, and is scarcely more soluble in hot water. It is insoluble in alcohol. It contains, when dry, 20.78 per centum of water.

To give a tabular view of these constituents, we have then, in cane juice,

Water,
Sugar,
Gum,
Vegetable mucilage,
Albumen,
Green Fecula,
Lignin,
Acetic acid,
Malic acid,
Acetate of lime,
Acetate of potash,
Super malate of lime,
Sulphate of lime,

Other principles may hereafter be detected in cane liquor; but the foregoing are all of which at present we have any evidence. It has been ascertained however, that the rind, in common with the other

plants of the same natural order, contains a large proportion of silica.* Of those principles which appear to be essential to the constitution of cane liquor, the proportions in which they are present vary with the nature of the soil and climate which produces the Cane, with the drought or humidity of the season, and with the maturity to which the plants have been allowed to attain. But before alluding to the relative proportions of these principles in cane juice, it is proper to glance at the probable economy of nature in their production.

The first modification which the sap undergoes, by the peculiar vessels of the Cane, results in the formation of vegetable mucilage, gum and green coloring matter. With the production of these, the farther elimination of the vegetable structure goes forward. Gluten and albumen are subsequently elaborated, and these are followed by Sugar, the acids and salts; mucilage and gum are the parent substances of all the principles of cane liquor, if we except the mineral bases, which are introduced along with water through the roots. In the early stages of the plant, accordingly, we find in the cane juice, little else than water, gum, mucilage and green coloring matter with minute traces of carbonate of lime, carbonate of potash and sulphate of lime. As the plant approaches maturity, the other principles, above mentioned appear; the quantity of water diminishes; gluten and albumen begin to exert their influence upon the gum, converting it into Sugar, at the same time giving rise to acetic acid and malic acid, which appear to decompose the carbonates of the unripe juice, and the acids accumulate, over and above, in the solution so as to be indicated by their usual effects upon the tests.

When the plant has attained its full maturity for grinding, little or no coloring matter is contained in the juice; while the gum and mucilage have given place to Sugar, and the proportion of albumen over that of gluten seems to have increased: a portion of the water has also passed off by evaporation, through the leaves, leaving behind, a more or less strong saccharine solution. If the season, however, be a moist one, the conversion of gum into Sugar is impeded by the want of concentration in the sap, as well as from a deficiency of solar influence, both of which conditions are requisite to perfect this change. Or, again, if the latter end of the cane season become wet, even after the plant has attained its maturity, water is taken up by the absorbing vessels, and the solution not only becomes dilute, but a conversion of some of the saccharine matter into gum ensues, attended also by a farther production of acetic acid.

Several analytical examinations of cane liquor have been made in different countries, which give us however, only an approximative idea of its constitution, as respects the proportions among its elements. According to the strength, or specific gravity of cane juice, it contains, dissolved in water, which is the principal vehicle of vegetable solutions, from 10 to 23 per cent. of principles soluble in that fluid, of which from 8 to 20 per cent. is Sugar, while the remainder is chiefly gum, fecula and albumen. In case, however, the juice comes from very immature Cane, so as not to afford above 6 or 7 per cent. of Sugar,

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*M. Avequin, (from France, and at present a resident in Louisiana,) has detected in the ashes of *bagasse*, or the Cane which has been through the mill, besides a large proportion of silica, carbonate of lime, carbonate of potash, and oxide of iron.

it is presumable that the other ingredients bear a considerably higher ratio to the Sugar, than is expressed above.

Of the solubility of these different ingredients, nothing need be said, with the exception of green fecula and gluten, as all the other ingredients are obviously soluble in water. Green fecula may owe its solubility, in part, to the mucilage, while the gluten is probably maintained in solution by the free acids.

The art of making Sugar consists in isolating the concrete Sugar from all the substances with which it is associated in cane liquor. We shall now give an account of this art as it is practised in Louisiana, and in Georgia and East Florida; treating the subject under the five following heads: viz. 1 Grinding of the Cane, 2. Defecation of the juice, 3. Evaporation, 4. Granulation, 5. Potting.

## PROCESS OF SUGAR MAKING IN LOUISIANA.

*Grinding of the Cane.* The Canes, as has been before mentioned, are brought from the field in carts, and delivered under a shed whose roof is a continuation of that of the Sugar house, and beneath which from 50 to 100 loads are capable of being protected, at once, from the weather. The Sugar house is a high, two story building, generally of brick from 100 to 160 feet in length, by 50, or 60 in breadth. In a majority of instances it is situated near the banks of the Mississippi, standing endwise to the river, and having one or two projections, one story high and 30 or 40 feet long, situated at right angles to that end of the main edifice which is contiguous to the river. The mill for the grinding of the Canes is placed at the remote extremity of the large building;—the Cane shed, alluded to above, being connected with the same end. That part of the building devoted to the mill and reservoirs for the expressed cane liquor, is separated from the rest of the house by a partition, and occupies a space of about 35 by 50 feet.

The Cane mill consists of three cast iron cylinders, which are arranged either in a vertical or horizontal position. The first arrangement is to be found in the older Sugar houses only; the horizontal, being that which is, at present, universally preferred.

The cylinders, in the vertical mill, are from 30 to 40 inches in length, and from 20 to 25 in diameter. They are furnished with cog-wheels fixed on the upper ends of their peripheries, and working into each other, the moving power being applied to the middle cylinder. These cylinders are mounted in an iron frame, consisting of two horizontal pieces, sustained by uprights; the openings of the frame contain brass bearings for the pivots of the three rollers, which brasses are capable of adjustment by means of cross keys and wedges, driven into openings in the frames, so as to force the rollers towards each other, and retain them at regular and unvarying distances. The surfaces of the rollers are fluted, with grooves of a small depth, which enable them to take a firm hold of the Canes, to draw them forward, and also to facilitate the running down of the juice from the Canes into a pan or cup, which is formed round the rollers at the lower part by a plate of iron, turned up all round at the sides and placed in the bottom of the frame.

In horizontal mills the rollers are somewhat longer, being sometimes 5 feet in length, and are arranged in a triangular form one above, and

two below. The power is applied to the upper roller, and motion is communicated from it to the others by an arrangement similar to that used with vertical mills. These rollers are also grooved like those which are vertical.

The mill is situated 8 or 10 feet from the ground, or in what may be called the second story of the building, in order to facilitate the passage of the juice to the kettles in the adjoining apartment. The canes are brought up to the mill by means of a machine called the Cane carrier. It consists of an inclined plane, 40 or 50 feet long, formed by a species of bagging, or of a double chain with wooden slats, inserted crosswise, into the alternate and larger links,—the whole forming a moveable band about two feet wide around revolving cylinders, or band wheels, the cylinders being kept in motion by the moving power of the mill. The plane is formed by this band at an angle of 35° with the horizon; upon which, the canes being laid, in pieces from 3 to 4½ feet in length, are gradually and regularly carried up to the mill.

In the case of vertical cylinders, a person takes the canes as they arrive at the mills, and holds them between two of the cylinders, at different distances up and down. As they pass through, they are turned, round by a circular piece of frame work, which is fixed fast to the upper and lower frames, and is made to encompass the middle roller at the back, and held in contact with it, till the ends are caught by the other roller. The second pair of the rollers is adjusted by the wedges of their bearings, so as to be rather nearer than the first pair, because the canes are flattened and crushed by the first pressure between the rollers, and require a still greater degree of pressure the second time they are passed. The space between the rollers does not, in either case, exceed ⅜ths of an inch. When the Cane is delivered to the horizontal mill, it does not require to be handled a second time after having been placed on the carrier; but, on arriving within a few feet of the mills, it falls into a wooden hopper whose bottom descends at an angle of 45° or 50°, from which it passes by the force of gravity between the rollers. The two lower rollers are placed very near each other, so that the canes are made to pass from the one to the other; but these two rollers, moving in opposite directions, cannot be suffered to come in contact. In this arrangement, it is obvious that the upper roller answers to the middle, and the lower ones, to the two outside rollers of the vertical mill. The canes, descending through the inclined trough above described, enter between the two rollers, and are carried forward to the other roller, and thus subjected to a second pressure, without the aid of a returner. The lower rollers are contained in a small cistern, which serves to receive the cane juice, when expressed.

The mill is moved either by cattle or steam power. No wind or water mills are known to exist in the State. Of the relative proportion of the steam and cattle power employed, it is difficult to speak with certainty. In 1828 the number of Sugar estates was 691, of which number but 120 were supplied with steam engines. Since that period, it is believed that the number has nearly doubled, leaving, however, the majority of Sugar mills still worked by cattle. It is however probable, that three quarters of the Cane are ground by steam mills, as they are invariably used on the large plantations.

When the mill is turned by cattle, the axis of the middle roller, in the

vertical cylinders, has long levers fixed across it; the arms to which the cattle are attached, extending nearly 20 feet from the centre; and to render the arms firm, the axis of the roller is carried up to a considerable height, and oblique braces of wood, by which the oxen or horses draw, are extended from the extremities of each of the arms, to the top of the vertical axis, thus forming a triangle. Four arms are provided, to each of which a pair of oxen, or of horses is attached. When horizontal cylinders are propelled by cattle power, the upper roller is turned by cogs at one end, which are caught by cogs on a vertical shaft.

When a steam engine is the working power, the gearing is much more compact; in this case, a bevilled cog-wheel gives the motion by being fixed in a horizontal shaft, on the other side of which there is fastened, a large cog-wheel, and this is turned by a pinion fixed upon the end of the axis of the crank or working shaft, of the steam engine.

When the canes have, in the manner above described, passed between the rollers, they are conducted out through an inclined trough, which usually goes through the side of the house, and thus they descend into carts that are constantly in attendance to convey them away to a convenient distance from the house, where they form, in the course of a few years, an immense heap of useless rubbish.*

*Defecation.* The cane juice is run off by a spout into two or more large vats, situated in the mill room, near the partition which divides it from the boiling room, sometimes called the Laboratory. These vats are rectangular, shallow boxes, made of cypress plank, and capable of holding many hundred gallons. It is not common to find these vats or the spouts leading to them, lined with copper or lead; although it is a precaution which is beginning to be observed by those planters who aim most at neatness and economy in their operations.

Various methods are adopted for the separation of the coarser feculencies of cane liquor, and which consist of pieces of the rind and of the pith, as well as of earthy matter; which last sometimes adheres to the lower joint of the Cane, or which it in some way contracts in being cut and hauled to the mill. Some place a wire seive upon the corner of the vat, through which the sap falls into the reservoir. Others fix a gauze division, vertically across the vats towards the extremity, which receives the sap, and through which it runs, as it flows into the other end, or is drawn off to the kettles. Others, again, in addition to a coarse seive, have recourse to subsidence, drawing off the contents of the reservoir by means of a copper tube bent at right angles, one leg of which passes through a stuffing box into the end of the vat next to the boiling room, and even with the bottom of the vat, while the other end is capable of being moved up and down in one direction, so as just to permit the surface of the juice to be discharged: in this way, the insoluble impurities are left at the bottom, and removed, from time to time, when accumulated in sufficient quantity. The channels and vats are also cleansed, with warm water, and finally sprin-

*The cattle are fond of feeding upon the expressed cane stalk, upon which they soon grow fat: occasionally, they are employed in repairing the levy as they afford a degree of protection from the depredations of the *Craw-fish*, a crustaceous animal belonging to the family *decapoda macrousa*.

kled with lime or ley from ashes. In very warm weather, this is done once or twice in 24 hours.

But the most difficult part of defecation is effected by the aid of lime and heat. In proceeding to the description of this process, it will be necessary first to explain the kettles and furnaces. These are situated in the boiling room or Laboratory, and occupy the centre of the main building. A set of kettles, four in number, is arranged in a line against the main building, on one side, or on both sides, according to the extent of the estate. One set occupies a space of about 30 feet in length by 7 to 8 feet in breadth; the tops of the kettles being raised from the floor from 2½ to 3 feet. They are set with the utmost precision in a very solid body of masonry, within which are situated the arches (which give support to the kettles), the furnace, and the flue which communicates heat to them.

The kettles are made of cast-iron; and are so set as to have their capacity considerably increased by the sloping rise of the masonry above their rims. This rise is about 6 inches, measured perpendicularly, the slope not differing sensibly from 45°. It is effected by using fire bricks of the first quality, ground to one another, so as to make the most perfect joints; and they are imbedded in a peculiar mortar, which consists in part of pulverized bricks. The space thus left between the kettles, which is 14 inches, prevents the contents of one from being dashed into the other, by excessive ebullition; and it also affords space for the construction of arches, which renders the setting more secure. The kettles of a set have different capacities: the diameter of the largest at its surface being 72 inches, that of the next 66, the next 60, and the last 54; or the largest is 66 and the smallest 48; the depth, in every case, being one-third and two inches of the diameter. The names apropriated to the different kettles are as follows: the largest is called the *grande*, the next the *flambeau*, the third the *syrop*, and the last the *battery*. The grande is at the end next the mill-room, while the battery, of course, occupies the other extremity of the series.

The furnace is under the battery. Its door and ash-pit are upon the outside of the building. The flue from it passes under the centres of the different kettles; and after having passed the last one, it turns at right angles and proceeds out of the building to the distance of a few feet, when it ascends, in an independent chimney, to a height at least equal to the horizontal circuit performed by the flue.

The shape of the furnace is slightly ovoidal,—its diameter being larger, by about one foot, at the grate than at the battery. The bottom at the battery is situated from 2½ to 3½ feet from the grate. The flue is horizontal at bottom, varying from 14 to 20 inches in height, at its commencement under the syrop, and growing more shallow by a few inches, as it reaches the other extremity under the grande. Its breadth throughout, is five-eighths the diameter of the kettle under which it passes. On reaching the chimney, the flue enlarges to the capacity of 2 square feet, of which dimensions it is continued out to the top of the chimney.

The chimney is carried up double; the inner wall is but 4 inches thick, or the thickness of one layer of bricks; the hollow space between it and the outer wall, being of the same width. The inner wall is tied to the outer, by laying a brick crosswise at each corner, at the distance of every

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4 feet; while a 4 inch opening is also left in the exterior wall on each side in the centre of the spaces between the ties, from the bottom to the top, and finally four lateral orifices of the same size at the summit. The consequence of this arrangement is, that the chimneys rarely, if ever, crack, like those constructed of solid masonry.

The grate of the furnace is formed of separate bars, whose extremities rest upon a projection of masonry. The bars are kept apart by means of short lateral projections, at each end, half an inch wide. They are five or six inches deep, one inch wide at bottom, two at top, not including the projections. The more modern grates have bars with projections in the centre also; as it has been found that without this precaution, they are liable, in consequence of the great heat to which they are exposed in that part, to suffer from curvatures.

An opening into the furnace, called the feed-mouth, for the supply of the fuel and the regulation of the fire, is left, whose diameter is about fifteen inches. It is formed by a circular casting, whose interior opening is about twenty-three inches. Its lower side is on a level with the grate. Below the grate is an ash-pit whose depth is not far from three and a half feet, having a rectangular opening, which is situated a little to the right or left of the furnace mouth, in order to protect the fireman from the heat of the coals which fall between the bars of the grate, and often form a glowing pile in the ash-pit.

The casting above described for the furnace mouth is without any door; in consequence of which and its limited size, another casting of different shape has been introduced, to some extent, into the most modern sugar houses. Its shape is rectangular, being on the outside sixteen inches high and twenty-four inches wide, with two doors, which are made double with an air chamber between. The bottom of this casting runs horizontally inward, through the side of the furnace, while the top ascends four inches and the sides diverge each four inches. One or both of the doors are opened at the charging of the furnace, according to the size of the wood introduced, and which is cut into pieces about three and a half feet long.

In describing the process of defecation, we shall suppose the operation of sugar-making to be in progress. The grande is charged by lifting the gate from the vats in the mill room,—a few buckets of its previous charge having been left in the grande to protect it from cracking on the admission of cold juice. Two or three gallons of its contents are then formed into a milk, as it is called, with from six to twenty-four cubic inches of slacked lime; and the milk is thoroughly stirred into the contents of the grande. As the heat of the juice increases, minute bubbles of air make their appearance, and a greenish, grey scum forms upon the surface of the liquor. When the temperature reaches 200°, the thickness of the scum is very considerable; and it assumes a darker color. Watery vapor now begins to form, and to force itself through the scum, causing it to crack. This stage of the process is sometimes called *yawing;* and is the signal for skimming. This is done with shallow copper skimmers, ten or twelve inches across, attached to long wooden handles; the scum being thrown into an adjoining vat, whence it is conducted by a gutter to the outside of the building. In some sugar-houses, it is thrown into a vessel provided for the purpose, and allowed to stand in order to give time to the clear part to subside,

which is returned again to the grande. The skimming is completed in ten or twelve minutes; when the the contents are said to be *clarified*, and are ready to be ladled into the flambeau. If the flambeau is not ready for its new charge, it continues to be skimmed in the grande, while it remains.

Meanwhile, the flambeau and syrop which are filled with juice that has previously been through the operation above described, are boiling and throwing up scums, that had escaped removal in the first process: these are pushed backwards by wooden oars, over the saddles separating the kettles, (and which are depressed two or three inches for the purpose) from the syrop to the flambeau, and are continually arriving to mingle with the contents of the grande. It is to be remarked that there is a gradual rise from the grande to the battery of a few inches in order to favor this operation of skimming backwards, and although the kettles only, are kept full, yet the ebullition elevates the surface of their contents so as to be even with the tops of the saddles.

The indications of a good clarification are the following: when the juice comes into the flambeau, it should be nearly transparent, and of a pale yellowish wine color, boiling freely with a large round bubble, and throwing up its additional fecula, with promptness.

When too much lime, or *temper*, as it is called, is added, the juice has an alkaline smell, and a reddish color, and boils with a small, flattened bubble: on the contrary, when there is a deficiency of temper, the boiling is not free, and a slimy scum adheres to the sides of the masonry above the kettles.

The variation in the dose of lime, depends upon the ripeness of the Cane, and its freedom from acidity. Fresh juice, from perfectly ripe Cane, is treated with only about six cubic inches of lime to the grande; but when the Cane is green, or frosted, the dose is increased to twenty-four inches, and sometimes even to thirty. The quantity of temper required oftentimes differs during the same 24 hours, on account of some difference in respect to moisture in the lands, producing the Cane. Hence, the process of liming is regarded as the most difficult part of sugar-making.

On a few estates, in approximating to the dose of temper, which a particular cane liquor may require, resort has been had to the following plan: a glass decanter, whose capacity is known, is filled with the cane liquor to be clarified, and portions of slacked lime, previously weighed out in three or four grain doses, are added, so long as they continue to occasion any precipitation, or the appearance of flocculi. The quantity added to complete this effect is noted, and an estimate is made from it of the weight of lime needed for the contents of the grande,—deducting however one-fifth of the proportional result in consequence of the preliminary essay having been conducted in the cold, whereas the defecation in the kettle is performed at a boiling heat, in which case, temperature compensates for the deficiency of temper.

In frosted cane liquor, some sugar boilers employ ley from ashes in place of lime, which they add in the proportion of about one quart, of the highest possible strength, as obtained in the common process of leeching, to the contents of a single grande.

In frosted cane liquor which has become very acid, a few planters are in the habit of relying solely upon heat to produce the defecation.

A method of clarification by steam, is coming into use upon, the larger and best conducted plantations. The sap is run off into wooden vats, lined with copper or lead, of the capacity of the juice cisterns, before described, and which they resemble in shape, excepting that they are deeper in proportion to their length and breadth. A copper steam pipe, between two and three inches in diameter traverses, five or six times, the bottom of the cistern, to which it is firmly attached. The cane liquor is introduced, and when the pipes are covered with it, steam is let in, either from a boiler provided expressly for it, or from the boiler of the engine, or it is the escape steam which is employed. The temper is now added; and the access of steam maintained, until the yawing occurs, when it is shut off, and the scums are immediately removed, or the juice is left until nearly cool, to be drawn off by an orifice situated within one inch of the inner bottom of the cistern through which the liquor is suffered to flow so long as it continues to run clear; after which it is closed, and the remaining portions are let off by another cock placed parallel with the inner bottom into casks, from which, after some hours of repose, about half of their contents is drawn clear. The clarified liquor is run from these vats (commonly two or three in number) into a general reservoir near the grande, traversing in its progress a course bagging filter, interposed for detaining any portion of light flocculent matter that may have escaped the previous process. From the reservoir it passes to the grande, and in boiling is skimmed and ladled forward as before described, more lime being added, if appearances indicate that there is not enough; and on the other hand, more fresh juice, if too much has been added.

A new method of clarification is offered, the present year, to the planters of Louisiana, by M. Guy Duplantier, of Baton Rouge. It is stated to possess considerable advantages over the ordinary process. So far as it is made known by the inventor, it consists in adding to the cane liquor in the grande a large dose of lime and subsequently, a certain portion of a substance whose name is not divulged, but whose properties are declared to be perfectly innocuous, inasmuch as it is asserted to be of frequent use in families in connection with food. The Sugar produced by this process is certainly better grained, drier and of a lighter color than that manufactured on the old plan, although it still retains a yellow tinge and possesses an alkaline odor. One or two crops have been fabricated upon this plan; and have commanded a higher price, by about one cent on the pound, than the ordinary Sugar of the country. Its advantages are offered to planters by the proprietor of the discovery for the sum of $1,50 on each hogshead of Sugar made after this method.

*Evaporation.* By evaporation is meant the dissipation of the water of solution by heat. The quantity to be evaporated varies with the ripeness of the Cane. In seasons when it reaches maturity, it constitutes between 70 and 80 per cent. of the juice; and on the other hand when from the early access of frost, or the unusual prevalence of wet weather, it is not allowed to ripen, it rises to from 85 to 90 per cent.

An instrument called the Saccharometor, or Hydrometer of Baumé, is frequently used, in order to learn the saccharine richness of cane liquor. It consists of an hermetically sealed tube, enlarged into a ball at one extremity, and loaded with shot sufficiently to give it an upright

position when placed in any fluid. The stem contains a coiled paper, upon which the degrees are marked. Or it is made of brass, with the degrees engraved directly upon the stem. Beginning at the top of the stem it is graduated from 1 down to 34°, this being the point at which it stands in a solution consisting of five parts of Sugar and three of water at 82° of F.

Cane liquor in Louisiana varies between 7° and 9° of this instrument, although it is often boiled when no higher than 6°; and very rarely it has been known mounting as high as 10 and 11°.

The saccharometer is not, however, regarded as affording a sure criterion of the proportion of Sugar in cane juice:—the preponderance of gum and green fecula in some cane liquors being so great as materially to influence their specific gravity; still its use is attended with very important advantage in arriving at an approximative idea of the saccharine matter.

The kettles have been described in the account given of defecation. The juice is ladled forward by means of wooden buckets, holding from five to eight gallons. They are furnished with wooden handles nine or ten feet long, which are inserted at one end into the bucket across its top;—the middle of the handle moving in a crotchet (like an oar) inserted into a timber running along in front of the kettles. The crotchet is placed half way between the central point of the kettle to be emptied, and the top of the saddle which divides it from the kettle destined to receive its contents. It requires two men to handle one of these dippers; but such is the facility of using the apparatus, that by its means, the battery is discharged and all the kettles scooped forwards in fifteen minutes.

The furnace is maintained at a uniform heat, day and night, from the commencement of the grinding season in November, till its conclusion in January,—stopping only a few times to scrape from the kettles the accumulation of rust, lime and earthy impurities which collect upon them, and which, if not occasionally removed, cause them to crack.

One set of kettles, only, is in use at a time, unless it be on those estates where the crop to be ground exceeds 200 acres. The quantity of wood required to keep the engine in motion for grinding the canes and for supplying the furnace for the kettles, varies from twelve to sixteen cords per day, although with bad cane juice it sometimes amounts to twenty cords. The kinds of wood used are, ash, maple, cypress, gum and laurel.

During the evaporation, all the kettles are maintained in ebullition, with the exception of the grande; the foam and bubbles usually mounting up to within an inch or two of the tops of the saddles. When the syrop or battery is likely to boil over, they are kept down by frequent blows with the paddles. The time required to bring a charge of the grande to the crystallizing point, varies from one hour to two, depending upon the setting of the kettles and the richness of the juice.

The transferring of the syrop is not performed at once. The three kettles which are hottest requiring to be kept filled, two or three buckets of juice are, from time to time, ladled forward to effect this object.

To determine whether the syrop has attained the proper consistency for granulating, or for being *struck*, as it is usually termed, a large

copper spoon, attached to a long wooden handle, is thrust into the battery and lifted into the air over the kettle: if the syrup is so thick that it covers the spoon in a thick pellicle, and drains from it slowly, presenting at the same time a grained appearance, from the little bubbles of air and aqueous vapor it contains, it is considered as sufficiently cooked; and it is instantly discharged by the bucket into an adjoining reservoir, from which it flows by channels to the coolers for granulation.

Another method of judging of the proper degree of concentration is to place the thumb upon the edge of the spoon, freshly taken from the battery, which occasions the removal of a drop of the syrop: this is drawn out into a thread by means of the fore finger. If the thread breaks dry and rises in a spiral form, the boiling is good.

Within a few years, a slight modification of the foregoing plan of evaporation has been introduced into Louisiana. It consists in the use of the *Bascule pan* of the French, invented by M. Guillon, and known also to American refiners by the name of the *tilt pan*. It is a copper vessel, mounted over a separate furnace, as represented in the diagrams.

*Fig.* 8. Bascule pan mounted upon its furnace.

*Fig.* 7. Horizontal section of the furnace four inches above the pan. The same letters indicate the same objects in both diagrams.

A. Ash pit: entrance twenty inches high by two and a half feet wide.

B. Grate.

C. Openings, or canals to the number of ten or twelve of the size of a brick; situated round the upper part of the furnace, through which the smoke and flame pass into a circular chamber to be conducted off by the flue to the chimney. This arrangement is adopted in order to spread the flame equally over the bottom of the pan.

*(o.)* Furnace door in the rear, upon the outer side of the building, 16 inches wide by 14 high.

*(l.)* Circle of two iron bands, forming a ledge, or gorge, into which the circular bottom of the pan falls one inch all round.

*(f.)* Bascule pan of a circular form and moveable on its axis. *(g.)* It is fourteen inches deep, five and a half feet in diameter and sixteen inches deep near the lip. Its weight is about 500 pounds.

*(h.)* Rings to which is attached a chain passing over a pully, *(i.)* and drawn by a hand piece, for the purpose of tilting the pan and causing it to take the position indicated in the figure by the dotted lines.

*(m.)* Wooden cistern into which the cooked syrup is struck, and from which it is run off by a channel into the coolers.

In using this pan, the juice is evaporated in the kettles as before, but is struck between 25 and 28° of the Hydrometer of Baumé into a large cistern capable of containing at least four or five hogsheads, where it cools, and deposits a thick sediment. From this reservoir, it is pumped up, from time to time, into a smaller one situated just above the bascule pan. The operation with this apparatus is as follows: The gate attached to the reservoir of syrop is raised and the bottom of the pan covered to the depth of four inches. A brisk fire being kindled under it, boiling soon commences: a slight scum rises, which flows down into the lip, whence it is removed by means of a hand skimmer. The striking point is ascertained as in the kettles, except that a ther-

mometer is often made use of to learn its approach. When struck, the thermometer stands from 236 to 238°.

To assuage excessive ebullition, it is customary to throw in a small piece of lard or of butter, just previous to the completion of the cooking; and at the moment of decanting the charge, notice is given to the fireman, who closes the ash-pit door to prevent the flames from rushing up into the boiling apartment to the inconvenience of the operator, who is stationed upon the rim of the furnace by the side of the pan. Immediately on its being discharged, it is suffered to fall back to its place, and the gate of the reservoirs is lifted as soon as possible, in order to cover the bottom of the pan before it becomes too hot from the action of the flame.

The time required to perform the operation varies from twenty to thirty minutes, and the result is a highly improved Sugar, with the estimated gain of one hogshead in fourteen over the old method.

*Granulation.* This part of the process is effected by running off the battery into shallow wooden vats, situated in a line with the kettles at the extremity of the house, opposite to that occupied by the cane mill. These vats are made of cypress plank, and measure from six to seven feet in length, from four to five feet in width, by twelve to fourteen inches in depth. Not less than six of these are used with one set of kettles; and in general a sugar house contains eight or ten, and sometimes a still greater number. A single strike covers the bottom, or forms a layer in one of these coolers from two and a half to three inches deep. Immediately after the first charge has been run into a cooler, it is thoroughly stirred with a wooden oar or spatula, in order to render the syrup uniformly consistent,—the last portions from the battery being more dense than the first. As soon as a thin crust of crystals forms at the surface, a second stirring is given with a view to disseminate the crystals equally through the fluid mass. A second charge is not introduced until the first has become thoroughly granulated and hardened so as to give it support, without mingling the two together. This requires a period from six to 14 hours, varying with the quality of the juice and the dryness of the atmosphere. The second charge is stirred like the first. In this way four batteries are struck into each cooler.

It sometimes happens that a skip which is not sufficiently cooked, comes to the cooler; in this case, granulation does not take place, and the defect is remedied, in some measure, by mingling with it, as soon as possible, a charge which is over cooked, or boiled higher than usual.

The effect of underliming also, is readily perceived when the syrop reaches the cooler, by the appearance of a white, glutinous froth upon its surface. This, in like manner, is remedied by adding to the next skip, just previous to striking, a small quantity of lime water; and on its arrival at the cooler, stirring the two skips intimately together.

*Potting.* This is the concluding operation in sugar making. It consists in the removal of the sugar from the coolers to the hogsheads in the draining house. It will be necessary, in the first place, to describe the draining house. In some sugar houses it consists of a long room from forty to sixty feet in length, forming an extension of the main building, in a line with it, and contiguous to the space devoted to the coolers, from which, however, it is separated by a partition. In others, it forms an apartment similar in extent, but instead of being placed in a line

with the main building, it is situated at right angles to it. But more generally the modern sugar houses are provided with two smaller draining rooms, both at right angles to the central building, and connected with it by doors contiguous to the space occupied by the coolers. The apartment is duly lighted by windows, and well provided with double doors, opposite each other, in order to favor ventilation. The floor consists simply of scantling, running crosswise, eighteen inches apart; beneath which are situated the molasses cisterns, each covering an area of not far from twenty square feet. Their depth is sixteen or twenty inches; and they are either made of brick and plastered with Roman cement, or of two and a half inch cypress plank, and rendered tight by caulking and pitching: the latter construction is the most common.

The empty hogsheads are arranged upon their bottoms over these cisterns, upon the scantling, with their joints left considerably open, and having three or four augur holes in the lower head, which are closed by Sugar canes on the inside,—the upper end of the Canes reaching nearly to the top of the hogshead.

After the granulation of the last skip of a cooler, it is usual to dig a conical hole in the contents of the vat, about a foot and a half across at top, in order to collect a portion of the molasses previous to the potting. In a little time the hole is partly filled with molasses, which is scooped out and carried to the molasses cistern in the draining house. This preliminary process, (not always practised,) is called *bleeding*. In some sugar houses the same thing is accomplished by having two plugs in the bottom of the vats, of about two inches in diameter, which come up through the sugar. These plugs being drawn, the molasses flows out through channels under the coolers, and is conducted into a general reservoir, from which it is transferred to the draining house. Still another method is, to have two holes through the sides of each cooler, even with the bottom, into which are thrust iron rods extending across the cooler, by which orifices are made for the draining of the molasses, and the coolers being inclined forward, its uncrystallized syrup flows out, and is caught in buckets.

The quantity obtained, however, by these methods, is very small, compared with what afterwards drains from the sugar in the hogshead. It rarely exceeds eight or ten gallons to a cooler. In many instances, bleeding is altogether omitted, especially when the weather is cool, as the molasses is then of service to the sugar, by enabling it to retain, for a sufficient length of time, that degree of heat which is requisite for its most effectual drainage.

The temperature at which the draining is performed, does not vary much from 98° or blood heat. When the weather is cold, however, it is potted rather warmer. It is spaded up from the cooler in thin slices, by an iron shovel, and carried in small tubs to the hogsheads. These, when filled, are usually covered with a broad cover. The house is kept as warm as possible, by not opening the doors and windows, unless in warm and dry days. A few draining houses are furnished with stoves: in them the temperature is constantly kept at 80° F.

When the sugar has drained, so as to feel somewhat firm, in order to give a free vent to the molasses, the canes are sometimes started a little from the holes into which they have been thrust, and after one or two days they are usually withdrawn altogether.

The average quantity of molasses which drains from each hogshead, is from forty to forty-five gallons. The draining is completed in, from twenty, to thirty days; after which, the hogsheads are filled up from one another, and are then ready for shipment.

On draining off the molasses cisterns, a greater or less deposit of sugar, called *cistern bottoms*, is found in these vessels. They vary, from three, to five hogsheads, for every hundred hogsheads of molasses. It is either transferred to the kettles, boiled up with lime water and evaporated as before, or sold to sugar refiners in the condition in which it comes from the cisterns.

## PROCESS OF SUGAR-MAKING IN GEORGIA AND EAST FLORIDA.

In describing the process of Georgia and Florida, we shall allude only to those particulars wherein it differs from that of Louisiana.

The buildings of the sugar works are either of wood or of tabby.* In general form, they differ somewhat from the plan adopted in Louisiana. It is more common to find the cane mill in a separate building. Steam mills are less common, and the cane carrier is unknown. The kettles are like those above described, although the masonry above their brims is of very inferior workmanship,—an attempt being made in many instances to remedy the defect by a lining of sheet lead, which covers the saddles and the sides in front and rear of the kettles, and even extends below their rims a distance of two or three inches. The chimneys are built without the open space for the circulation of air, described in those of Louisiana. Wooden chimneys for carrying off the vapor from the kettles are not in use; and the facilities for transferring the syrup from one kettle to another, are inferior in a majority of the houses.

But little uniformity prevails in the method of clarification. The temper, however, is generally added by weight; and differs, from two, to eight ounces for the hundred gallons of juice. With some, it is added in the first kettle, as in Louisiana; with others, in the cane liquor vats, in the cold; and again with others, it is added in copper clarifiers, set to a distinct furnace. When the operation is performed in the cold, the whole charge of temper is not added at once; but a quantity equal to one-quarter or one-third of the whole charge, is reserved to be added, when the liquor has attained the concentration of 15° of Baumé. After having added the lime to the cold liquor, it is suffered to rest for an hour, in order to allow the precipitate to subside; after which, the clear supernatant liquor is drawn off to the grande. Clarification by steam, and concentration by the bascule pan, are, so far as we are informed, unknown in Georgia and East Florida.

The thermometer is more extensively employed here than in Louisiana; and the point at which the boiling is completed, falls within a lower range. It rarely rises so high as 236°, and often falls as low as 229°.

On some estates the battery is struck into coolers, as in Louisiana; while on others, it is ladled out into a reservoir, from which it is carried

* An extemporaneous, calcareous shell-breccia, formed by mingling in moulds, oyster shells, sand and quicklime.

in buckets, before granulation, to the draining room, and put into half hogsheads, barrels, &c. which are tapped in twenty-four or thirty-six hours, and suffered to drain for sixty days. The draining houses are not kept of a uniform temperature by stoves.

## EXPLANATION OF THE CHEMICAL AGENCIES IN SOME OF THE FOREGOING PROCESSES.

Nothing need be said under this head. of the first operation in sugar-making. The theory of defecation, however, is explicable only on chemical principles. The lime, it would seem, operates by converting the vegetable mucilage into gum,* and by forming an insoluble compound with the coloring matter. It likewise enters into union with the gum, rendering it more soluble; in consequence of which, the cane liquor becomes more fluid, and presents less opposition to the subsidence of the precipitated fecula. The temper appears to exert an influence in defecation, by neutralizing, also, the free acids, which hold the gluten in solution, and thus rendering this fermentating principle insoluble.

The heat coagulates the albumen which is not previously rendered uncoagulable by its union with the lime; and in rising to the surface, in flocculi, through the fluid mass, it brings along with it, in part, the precipitated fecula, and there holds it in the form of a more or less tenacious scum. We have here spoken of *that part of the albumen that is not previously rendered uncoagulable by its union with lime*—for it is probable that the larger portion of this principle is, by its union with lime, deprived of the power of coagulation.

As the evaporation proceeds, and the syrup increases in concentration, the fluid compounds, of lime and gum, and of the same alkali with albumen, and which are lighter than the saccharine solution, rise to the top of the kettles, bringing along with them, in their passage, some of the remaining particles of green fecula, and fragments of the rind and pith of the cane, together with other impurities. Only a part of these are got rid of by the skimmers; the major portion, being scum, passes back over the saddles to the grande, to be brought forward, again and again, in each successive charge, and finally to be skipped off with the granulating syrup.†

The liquor from unripe canes, requires more temper, for the reason that it contains more coloring matter and more gum: the reason for adding more alkali to gummy syrup being, that, without it, its visci-

* As a reason for the opinion before expressed, that the coloring matter is dissolved in the mucilage, rather than in the gum, which is the more general impression, it may be remarked, that where no temper is employed, as has been practised by some sugar makers, it has been found that nearly all the fecula was got rid of in the course of the operation, which is what might be expected, if that matter owes its solubility to the agent in question; since it has been ascertained, that vegetable mucilage, on being boiled in a large quantity of water, is changed into a substance resembling gum. If this view of the subject be correct, the chief objection against dispensing with alkali, altogether, would appear to arise from the mucilaginous or viscid character imparted to the liquor by the gum, thereby impeding the precipitation of flocculent matter, and which can be overcome only by having recourse to temper.

† In consequence of the deterioration of syrups from this cause, we have known of instances where the syrups become finally incapable of granulation and are sold as molasses.

dity would interrupt the process of granulation and check the draining in the hogsheads. It is cane liquor of this description to which the sugar boiler frequently adds a dose of lime water just previous to striking.

The broad surface of the coolers and the stirring contribute to a speedy and uniform granulation; inasmuch as evaporation is promoted and the syrups of different densities, which contain variable portions of uncrystallizable matter are thus equally blended together. The second stirring, or that after the crystals have begun to form, has the effect o distributing nuclei of crystallization to portions of the fluid, in which the did not previously exist.

The theory of potting depends upon the thorough disintegration of the hard cakes formed in the coolers, and in transforming it whilst in this state, and while sufficiently warm to keep the gummy and albuminous substances which are every where contained in it, fluid,—in order that they may flow out through the openings left in the hogsheads, along with the uncrystallized syrop. For, if the proper degree of pulverization be not given to the contents of the coolers, the fluid matter is prevented from finding a sufficient outlet; and if, by the excess of cold, the gummy matter stiffens, the draining is completely checked, and the granulated sugar becomes again dissolved;—the whole forming a clammy, pasty mass. Hence the reason also for covering the top of the hogsheads, and of regulating, artificially, the temperature of the draining rooms.

The bottoms of the cisterns are covered by matter consisting of granulated sugar, carried from the hogsheads entangled in the molasses, and also of an additional crystallization of Sugar which takes place, as the syrup which drains from the hogsheads, or is derived from the bleeding of the coolers, becomes colder, and as a portion of its water suffers evaporation. The granulation ceases at that point, where the density of the medium creates a force superior to that of the molecular attraction of the particles of the Sugar. But as the cistern bottoms are mechanically associated with many impurities, and especially with a large quantity of gum, the addition of lime in the re-boiling becomes necessary, in order to promote the fluidity of the syrups.

As a reason why acid cane liquor requires no temper for its defecation, it may be supposed, that the acetous fermentation has taken place at the expense of a portion of the gum; and that the precipitated fecula is not therefore prevented from rising through the liquid. The albumen also remains in the solution, which being coagulated by heat, assists in carrying to the surface the precipitated flocculi.

It is perhaps impossible to account, satisfactorily, for the superiority attributed to ley in the defecating process. If however, it be conceded, that alkalies have a stronger affinity for coloring matter and for albumen, than for Sugar—and there is much to favor this opinion—it would then appear to depend upon the different circumstances of the two alkalies arising out of their solubility. The lime, it will be remembered, is added in the condition of a cream, while the potash is employed in the state of a transparent solution. The former falls to the bottom, and its solution goes on slowly, the liquor in its vicinity being operated upon not merely so as to cause the precipitation of the geen fecula and to give rise to the compounds of gum and albumen with the lime; but owing to the saturation of the fluid with the alkali, the Sugar itself entering into union with it; whereas, in the other case, the perfect solubility of the potash

favors its being brought into immediate contact with every portion of the liquor, and of its exhausting itself, simply in producing the desired effect, without attacking the Sugar.

The advantages of the clarification by steam arise out of the more effectual separation of the flocculi of green fecula and albumen. This follows from the time allowed for the formation of the scum and for the settling of the sediment in the clarification vats, and when an intervening cistern is employed between the steam vats and the kettles, in which the liquor is suffered to become completely cold, an additional sediment is deposited.

The utility of the bascule pan depends upon several circumstances. In the first place, the syrup being drawn off at 25° to 28° Baumé, and suffered to cool, deposits a large portion of fecula which is not otherwise wholly got rid of, and in the second place, the greater rapidity, with which the evaporation is performed, and the power of decanting the whole charge at once when the working is completed, are great advantages; whereas on the old plan, it required several minutes for this operation, the consequence being that the last portions ladled out were over cooked, or burnt, and a portion was necessarily left behind, to keep the battery from cracking, which of course is diluted with the charge coming from the syrup, and thus kept still longer exposed to the deleterious influence of heat and air.

Of the chemical composition of molasses, on account of its variable character, no precise account has been, or perhaps can be, given; that it is an aggregate of numerous principles, however, cannot admit of a doubt. The prominent ingredient in the syrup is dissolved sugar, or syrop; next to this, gum may be mentioned; after which, the compounds of both these substances with lime, and finally, the compound of lime and albumen, free acetic acid, acetate and super malates of lime and potash, sulphate of lime, and various insoluble matters collected in the operations of harvesting the Cane and manufacturing the Sugar.

## IMPROVEMENTS SUGGESTED IN THE MANUFACTURE OF SUGAR.

The account which has been given of the actual process of sugar-making in the United States, has not embraced individual improvements or experiments: we have had in view to give merely an account of the prevailing method. The results of private experience, where they are deemed valuable, will be attended to, more or less, under the present head.

*Sugar House.* The sugar house should be placed, as nearly as possible, in the centre of the cultivated portion of the plantation. This is particularly indispensable, on those estates where advantage cannot be taken of canals for transporting the Canes in flats, as is done on the tide swamp land of Georgia. In Louisiana, where the whole crop is brought in by land conveyance, inattention to the central location of the sugar house is a source of vast inconvenience to the planter. The majority of their houses are still within 100 rods of the river; the consequence of which is, that the wood, to the amount of two or three cords to each 1,000 weight of Sugar made, must be transported, three quarters of a mile or a mile, and a large part of the Cane from nearly the same

distance. That this is a serious burden will readily be perceived, when it is recollected that the amount of Cane from a single acre does not materially vary from 35 to 40 tons, and that the roads, from the clayey nature of the soil, are often exceedingly heavy.

A slight rise of ground should be sought for the buildings; and in default of a natural one, an artificial elevation should be constructed, so that the water from the roofs, and the scums and washings of the house may pass off without inconvenience. A neglect of this precaution is attended with muddy premises, a tainted atmosphere, and badly ventilated apartments. It is particularly to be recommended also that the carts which arrive with the Cane should ascend an inclined plane, commencing at the distance of 40 or 50 feet from the cane shed, rising about four feet, and terminating by a perpendicular fall of this depth, just within and under the roof of the shed. The shed should slope off toward the main roof of the building, meeting it at the distance of 15 or 20 feet, and forming with it a channel to receive the waters of both roofs; it should have a slight declination towards one extremity to lead the water off at one spot, and thus leave the front part of the cane shed always dry. The carts will ascend this plane and have their loads tilted so as to fall under the shed, upon the dry, hard ground.

For the general form of a sugar house, we will give an outline of two; one of which is in Louisiana and the other in Georgia: and which appeared to possess the greatest advantages, and on the whole to be most worthy to be copied as models. *Fig.* 5 represents that of Louisiana. It is built of brick. The length of the mill-room A is 64 feet, that of the boiling room B 68; and the width of each is 40 feet, with a height of 18 feet to the top of the joists. The draining rooms D D, are 60 feet long by 36 wide and 10 high. E is the cane shed 50 feet by 75. (It is not, however, in this instance of the form above recommended). A shows the position of the cane mill, b that of the piston and cylinder, d that of the boilers which are beneath the floor of the mill-room, e the cane liquor vats, f the cane carrier, h a flight of steps to descend to the boilers. E is a brick pavement raised four feet above C, and situated three feet below the floor of the engine and mill room. C is one foot above the ground upon the outside of the building, and 18 inches below the tops of the cisterns in D D. i i i, &c., are the molasses cisterns, three of which are contained in each draining room, 15 inches deep, made of strong four inch cypress plank, well keyed together, and covered with five or six inch scantling beams, for the support of the hogsheads. k are the coolers, l the kettles, m the chimneys, n the furnace sheds having brick tops.*

The sugar house in Georgia referred to, may be understood from figure 1. It is 240 feet long by 39 wide. The length of the engine room A, is 10 feet, the mill room C, 20½, the boiling room D, 60; the cooling room E, 44, and the draing room F, 98 feet. The height of the engine, mill, and boiling rooms, is 26 feet from the foundation of the walls to the top of the joists, and of the cooling and draining rooms 16

*This sugar house is on the estate of Mr. James Porter, on the Bayou La Fourche. The bricks were made on the spot, and the expense of the building, separate from the bricks, was about $3,000.

feet. The walls are all constructed of tabby; and the floors of the cooling, boiling, and lower mill rooms are of the same material. The engine boiler is placed in a small wing on the outside of the building. G is the engine chimney, H the chimnies of the furnaces, a a the spaces devoted to the two kettles, the cane vats and clarifiers, and b the coolers. A wooden rail way extends through the centre of the cooling and draining rooms, upon which a car moves for carrying the granulated Sugar to the hogsheads. The sugar hogsheads stand in joists resting on a centre wall, and the projecting ledges of the walls of the room. The joists are three inches wide, twelve inches deep and a few inches apart: under them, on each side of the centre wall, are two floors of tongued and grooved boards, sloping at an angle of 18° to a gutter six inches wide and deep in the centre between them, and leading to the molasses cistern. The molasses dripping from the sugar hogsheads is received on these floors, and thence runs to the cistern. The two molasses cisterns z z, contain each 7,000 gallons, and are constructed of tabby, plastered with Roman cement. The walls are eighteen inches thick and five feet high, and the floors are 6 inches deep: they are sunk four feet below the surface of the ground, and are covered with tongued and grooved boards, to exclude rats and dust. The line of the floor is the same in the boiling and cooling rooms, and deviates only six inches in the curing rooms.*

*Cane Mills.* Those with horizontal rollers possess decided advantages. They require scarcely any attention in the feeding, and are free from the jirking and straining, which attend the vertical rollers. The rind of the canes is less bruised and the pith less broken, because each cane passes between the cylinders separately, without overlapping; and the consequence is, that the cane juice is much clearer than that afforded by the vertical mills. Besides, the vertical cylinders generally have the disadvantage of wearing out unequally, while the horizontal wear with perfect uniformity. Cylinders five feet long by two feet and four inches in diameter, are found to answer the best purpose. Cane mills with wooden cylinders cannot be used except with great loss. And it is strongly to be recommended that animals as the moving power of these mills be replaced by the steam engine.

The planters of Louisiana have, very judiciously, given the preference to high pressure engines, the majority of which are of ten horse power, and supplied to them from Tennessee and Ohio. These have the advantage over low pressure engines on many accounts. They are less expensive in their construction, and can be worked with one-seventh part of the water required for condensing engines. They are also less wasteful of fuel, are of smaller weight, occupy less space, and are more easily kept in repair. No accident, so far as we have been able to learn, has ever occurred on plantations, from the bursting of boilers.

*Receivers for Cane Juice.* At least three of these should be provided for each set of kettles in operation. A frame with a coarse wire sieve should be placed upon the corners of the receiver, while it is filling, in order to detain the coarser impurities; while a sieve with finer meshes

*These sugar works are on the Hamilton and Cowper plantation at Hopeton, five miles from Darien, and were erected under the direction of Mr. J. Hamilton Cowper, one of the proprietors.

should be fixed vertically across the end of the vat, into which the channel is delivering the juice. There is perhaps, on the whole, no more advantageous method for draining off the contents of the kettles, than that of the bent copper tube, working in a stuffing box. A sufficient period should be allowed for the liquor to deposit the insoluble earthy matter, which it contains, before drawing it off for defecation. It is important also, that the vats and connecting troughs should be lined with lead or copper, since it is impossible, by any cleansing, to free wooden troughs of the tendencies to fermentation, which they impart to cane liquor. This is the result of the impossibility of drying wooden vats and vessels: the wood when once wet, retains its moisture, and being in a state of decomposition, it is constantly exerting its influence upon the sap. By drying, we prevent putrefaction. "When putrefaction is determined," says Berzelius, "it goes on very fast, which leads to the belief, that the products which result are equally endowed with the property of exciting a similar action to that which determines the formation of the process." Hot water should be employed in the cleansing operation, and is preferable to lime, as will be shewn hereafter.

*Defecation.* This is the great problem of sugar making: and that it is one of no easy solution, is proved by the unsatisfactory experience of centuries. We shall venture to advance a plan relative to this subject, which is in some respects new, and is founded on the view we have taken of the chemical composition of cane liquor. The cane juice, after having been suffered, by standing, to deposit its coarser impurities, should be drawn off to a rectangular vat, having a double bottom, and whose depth is equal to its diameter: in this vessel it must be subjected to a temperature of 208 to 210° F. From this vessel, after a repose of about 45 minutes, its clear contents are to be drawn, by an orifice placed one inch above the bottom, into a vat of similar construction, whose top is situated four inches above the bottom of the first,—taking the precaution to pass the liquor, in its passage from one vat to the other, through a filter of coarse cotton bagging. What remains in the vat is then to be drawn off through an orifice, on a line with the bottom, and suffered to settle in casks, the clear portion being added eventually to the second vat. The filtered liquor, in the second receiver, is now treated with a milk of lime, formed by adding perfectly impalpable, slacked lime to water, in the proportion of not less than four cubic inches to a gallon, the steam being let in previous to the addition of the lime. The quantity of temper is to be regulated as follows: after the additions of temper, portions of the liquor are examined, from time to time, by passing it through a fine cloth filter, and adding to it, in a wine-glass, a tea-spoonful of clear lime-water: so long as a cloudiness appears in the liquor, on the application of this test, more milk of lime must be added. The heat must be carried to 210° F., when the steam must be cut off, and, after a repose like that above described, it is run off by means of an orifice, one inch above the bottom, until it begins to appear cloudy, when its orifice is closed and another, situated on a level with the bottom, is opened, and the remainder is run off into a tub or barrel to settle for future decantation. The defecated liquor is made to traverse a bagging filter, as before, on its way to a general reservoir near the grande, and which should be capable of holding 1,000 gallons. Sulphuric acid, diluted with 20 times its weight of water, or tartaric acid dissolved in 10

times its weight of water is added, from time to time, to this reservoir, in quantities sufficient to maintain its contents, as nearly as possible, in a state of neutralization, or in such a condition that there will be no alkaline reaction on paper stained with yellow by a strong decoction of tumeric.

The reasons for the foregoing plan are the following: Heat alone is sufficient for the separation of the albumen, and a large portion of the green fecula. The first heating; therefore, coagulates the albumen completely, the greater part of which will rise to the surface, in a scum, more or less tenacious, bringing along with it a part of the precipitated fecula; while another portion of these impurities then falls to the bottom, along with insoluble earthy matters, pieces of cane, &c. And on being transferred to the second vat, the quantity of lime required for rendering insoluble the balance of the coloring matter in the juice is greatly reduced, while its mischievous influence in rendering albumen soluble is avoided, since the principal part is already removed. The filters collect those flocculi which had escaped the process of subsidence; and the addition of sulphuric acid, or of tartaric acid, removes from the defecated liquor all excess of lime which it may contain, and the insoluble precipitate of sulphate of lime subsides on the bottom of the general reservoir, without going forward to injure the kettles by the formation of a thick crust.

It will be at once apparent, wherein the present method of defecation has advantages over that where steam vats are employed, since by that plan a large portion of the albumen was rendered permanently soluble by the lime employed for throwing down the green fecula, and besides, no measures were taken for getting rid of the superfluous alkali remaining in solution, after the defecation was completed,—the alkali being left to enter into union with the Sugar, and by its subsequent action upon it, in the kettles, to convert it into gum.

Compared with the general practice of liming in the kettles, its superiority is still more apparent; inasmuch as the same advantages are found here, as in the above case; and moreover, the present plan of repeated subsidence renders it completely feasible to separate a heavy precipitate of impurities, which on the old plan adhere, to such an extent, to the sides of the kettles, forming in the last of the series, a carbonized matter, which discolors the Sugar, and interferes with the processes of granulation and draining.

Very acid cane liquor will afford the best Sugar without the use of any alkali, as has been fully demonstrated by the experience of several sugar planters. Although heat alone may be insufficient to throw down all the green fecula, still what remains had better be suffered to mingle with the syrup, than to resort to the employment of temper, since the soluble acetates of lime or potash, according as one or the other alkali has been resorted to, are formed abundantly; although their solubility causes them to drain off, for the greatest part, with the molasses, yet still, a portion remains with the Sugar, which by deliquescence and spontaneous decomposition, (all the soluble acetates being subject to these changes) render the Sugar, on a little exposure to the air, moist and acid. The molasses also suffers a similar deterioration as respects acidity. Indeed, it is presumable, that even when ripe cane juice has been manufactured into Sugar, the natural portion of acetates existing in them, is, to a greater or less degree, the occasion of these changes.

There would appear to be the most satisfactory evidence, from the experience of sugar makers, that potash or ley cannot be employed in place of lime, for defecation. Whether its alcalinity is so great, that it attacks the sugar, and forms with it a saccharine compound, which afterwards undergoes a spontaneous decomposition, and thus renders the sugar clammy, cannot with certainty be determined; but that sugars made with the aid of this temper, are more liable to suffer from shipment, and to become acid, than those made with lime, there cannot be a doubt.

The employment of alum is still more objectionable than that of potash, although it is still sometimes resorted to, just previous to striking the battery. Sugars made in this way, however, are well known to be liable to the clammy change above alluded to.

The use of clay and animal charcoal in defecation, is not to be recommended. To say nothing of the expensiveness of the latter article, they involve the loss of much time, and a great waste of cane juice, without any sensible improvement in the clarification.

It has been imagined that the vegetable mucilage from the slippery elm, the okra, and from flax seed, have been of service in particular instances, when added to the cane liquor in the kettles; but the evidence on this subject is not yet satisfactory. The operation of these agents can be attributed to nothing but the low specific gravity of the mucilage which causes it to float on the surface, and, by its viscidity, to impart tenacity to the scum. The effect of a large dose of lime added to the high temperature of the last kettles, must, doubtless, be to convert it into gum, which will interfere with the granulation of sugar, and go to increase the quantity of molasses.

*Evaporation.* Before describing our views upon this subject, it will be necessary to allude to some alterations in the construction of furnaces and kettles. The arrangement to be recommended, is that of four kettles or pans, set in a line against the wall, and all heated by one furnace.

Much might be urged against the employment of the ordinary cast-iron kettles, although their form is suited to evaporation under certain circumstances: when mounted on independent furnaces, without being so deeply sunk in masonry, they are capable of subserving useful purposes in evaporation; but arranged in a series of four kettles to one furnace, they undoubtedly form a very ineligible apparatus. Their setting is attended with an expense of three hundred dollars: and this requires to be repeated on an average, once in three years, owing to cracks in the masonry, caused by the different expansibilities of the iron and the brick work; without taking into the account the liability to accidents from the cracking of kettles, owing to the formation of a crust upon their sides. Moreover, it should be remembered that owing to the shape of the chamber in which the kettles are hung, and the disadvantageous surface presented by the kettles to the flame and heated air, whenever it becomes necessary to extinguish the fire, either for the purpose of cleaning the kettles or repairing the masonry, a great length of time and waste of fuel is required to recommence the operation. But, without alluding further to these disadvantages which are confessed on all hands, or without suggesting in this place a snbstitute for them, we will proceed to make a few remarks upon that construction of the furnace which appears best adapted to these kettles; taking it for granted, notwithstanding all the inconveniences which appertain to their use, that the immense quantity of them

now on hand in the sugar country, the cheap rate at which they can be bought, and the force of custom, all operating in their favor, will yet, for some time to come, prevent their falling into disuse.

The entrance for air, technically called the *twyer*, should be made as far below the level of the grate as the situation will conveniently allow. It should, in all cases, be furnished with an iron door; in order to allow of the regulation of the influx of air, whenever it may be requisite. The area of the entrance ought to be governed by the sum of the areas left open between the bars of the grate; and its area should not exceed two-thirds of those open spaces, in order that the air may strike against the grate with sufficient force.

It will be found advantageous, also, not to have the entrance for air united with the ash-room entrance. The latter should be directly under the grate, and must be kept constantly shut, while the twyer can be placed at any lateral distance which is most convenient. The ash-room need not be large, as it will be found best to remove its contents at short intervals, into an ash-house built of brick, with a roof of the same material, and situated beneath the roof which protects the furnace men from the weather.

The method of constructing grates in single bars, with shoulders at each extremity and in the middle, so as to leave spaces of one inch between, as already described, is highly judicious; as is, in like manner, the plan of making the lower side of the bar half the thickness of the upper side. Space enough upon the bearings must be left to allow of the expansion of the bars. Attention to these points prevents the warping of the bars, as well as the falling through of large coals, and the melting of the bars from the embers in the ash room. A grate, the sum of whose areas left open between the bars, varies from twenty-two to twenty-six inches square, will generally be sufficient.

In order to prevent the fuel from being expended to waste, the fire room should be surrounded with those substances which conduct heat the slowest. The side walls should, therefore, be double, with a space two and a half inches between them, and these walls should be tied together by bricks from space to space; and this may either be left empty or filled with ground charcoal or coke. The inner walls must be built of fire-brick set in fire-lute.

The feeding door most deserving of recommendation, is that already described. The common plan of leaving the feeding hole open, is attended with the disadvantage of interrupting the draught of the furnace; as it produces a constant influx of cold air, which greatly refrigerates the furnace and its contents. The grate bars should be placed in a line with the feeding hole.

The centre of the battery should be placed about one foot in advance of the centre of the grate, in a direction towards the chamber, in order that the flame, in its oblique passage to the chamber, may be brought into contact with that kettle. To assist in effecting the same object, as well as to prevent the draught from sweeping the ashes into the chamber, a perpendicular rise of masonry should be carried 12 inches high on that side of the furnace from which the chamber originates, and curving up on the sides, as high as the bottom of the battery.

The lowest part of the battery should be from 30 to 36 inches above the grate. The walls of the furnace should be carried up perpendicu-

larly to the height of 24 inches; when they should be gradually brought in on the side farthest from the chamber, and afterwards on the others, to meet the battery at a line four and a half inches below the brim of the kettle. The angle at which the brick arch should meet the kettle, should be as obtuse as is consistent with strength, to prevent the burning of the syrup, when the kettles are emptied below the line of the masonry.

The top of the one foot perpendicular rise on the side of the grate from whence the chamber runs, fixes the elevation of the bottom of the chamber throughout, which should be semi-cylindric; having its cross sections, nearly semi-circles, increasing in width under each kettle as you proceed towards the grande.

The throat between the fire-room and the chamber will be semi-circular, at top as well as at bottom, from the arch thrown across to help support the battery and syrup. The area of the throat should be equal to the free space left between the grate-bars. The increase given to the width of the chamber, directly under the kettles, should not be less than five-eighths of their diameter.

Between the second and third kettles and between the third and fourth a similar contraction in the area of the chamber takes place; the object of which is to cause the flame to reverberate in its onward passage. The semi-circular shape given to the bottom of the chamber is important, inasmuch as the heat which it radiates, impinges perpendicularly upon the sides of the kettles.

As the arches form the weakest points of the masonry, and are most exposed to the action of the fire, too much attention cannot be paid to their construction; particularly to that of the first between the battery and the syrup. To prevent the expansion of the brick work from throwing down the furnace, bracing bars of iron should be placed across the furnace, at the top, on each side of the battery and between the syrup and flambeau. These should be made of square bars of iron, passing at the ends, secured by nuts, through the heads of the two other bars, one and a half inch wide and three-fourths of an inch thick, placed on the outside of the masonry, and extending below its foundation. The cross-bars should be placed so near the top of the works as to be removed from the expansive action of the fire.

A trough, 10 inches square, should extend from the inside of the first arch to the end of the chamber passing through the vent across the bottom of the flue, or chimney, to the open air; when the furnace is in operation, the hole, where it comes out, being closed by bricks, set without mortar joints, except the exterior face. This trough is necessary for the removal of the soot and ashes which accumulate in the chamber.

The vent should be a single opening, and should be contracted to an area equal to the free space between the bars of the grate.

The chimney, or flue, is one of the most important parts of the furnace. If its horizontal area is made too large, the draught is much diminished, and the soot collects and becomes troublesome; for, when the sides of the flue contain a larger surface than can be duly heated, the necessary rarefaction of the air passing through it, is destroyed. The rule for the area is to allow a space exactly equal to the free space between the bars.

As the chimney stands separate from the house, it is necessary that it should have a sufficient breadth of base, in order to protect it from the action of the wind. Each side of the chimney should be, at least, one foot in

breadth for every ten feet in height; and the area of the flue near its base, ought not to exceed one-third of the area of the chimney. The height of the chimney should not be less than the length of the chamber, and may be carried a little higher, if the draught is not sufficient; for the longer the chimney is, the more perfect is its draught, since the tendency of the smoke to draw, or rather to press upwards, is in proportion to the smaller weight of the column of air included in a chimney, compared with an equal column of external air. The walls should be double, as already described, but the number of openings might, probably, be diminished with advantage towards the bottom of the chimney, as the access of a strong current of a cold air to the interior walls ought to be prevented.

The following system of boilers is recommended as best suited to evaporation, where it is carried only to the density of 25° or 28° Baumé in a set of skimming boilers. It, Figs. 3 and 4, consists of three rectangular, flat bottomed pans, made either of copper, or of boiler sheet-iron, whose length is greater than their breadth. Their sides slope at angles somewhat different in each, rising quite to the top of the masonry, so as to dispense with a rim of brick-work above. Pan A is six inches longer than wide, the longest side being in a line with the set. Its capacity, when filled, to the dotted line o, seven inches from the top is equal to a 60 inch kettle. Its depth is 16 inches. Its ends rise from the bottom with an outward slope, so as to form with the dotted line a, an angle of 35°. Its sides flare still more, so as to form, with a line perpendicular to the bottom, an angle of 45°. Pans B and C have the same width with A, at top. B is ten inches longer than A; its ends rising with a slope, so as to form an angle of 30°, and its sides one of 35°. The third pan C is six inches deeper, and sixteen inches longer than A, the ends rising at 25°, and the sides at 30°. The edges formed by the meeting of the ends of the kettles A and B, and of B and C are sunk three inches below the other edges, in order to perform the operation of skimming. A spout x, passes through the masonry from the bottom of the pan A, whose diameter is at least four inches. Bars of iron one inch square should cross the body of the masonry at the points v v v v, and be secured by screws and nuts to upright iron bars on each side, which descend to the foundation of the works.

The chamber E has a plane bottom, with a slight declination from the vent G, to the throat I: the distance from the bottom of the first pan to the floor of the chamber being 18 inches, and that from the bottom of the third to the floor, at its extremity, being eight inches. The distance from the grate to the bottom of the first pan is 36 inches, and the centre of the pan is one foot in advance of the centre of the grate. The chamber has throughout the width of the pans under which it passes, increasing in breadth as it proceeds through the arches between A and B, and between B and C, to conform to the increased width of the pans. In passing through the first arch it diminishes in depth to nine inches and in passing the second to seven. The chamber terminates by a perpendicular wall, in which there are eight openings, distributed across its breadth at equal distances; the sum of the areas of the openings equalling the free space between the bars of the grate, of which size, also, the flue should be carried out to the top of the chimney.

The furnace is nearly square, and the bars of the grate have all the same length, varying but little from four feet. They should be provided

with shoulders, at each end and in the middle, as above described. The rules before given with respect to the feeding door, ash pit, twyer and chimney, can be applied advantageously to the present plan.

The contents of B and C can be ladled forward by means of buckets with valves in the bottoms, which open when the buckets are depressed in the fluid, and close on being lifted out of it. A is drawn off by the orifice x. Skimmers with a rectangular, instead of circular, edges must be employed for removing scums.

The advantages of this system consist in the larger surface offered by the pans—the evaporation of a fluid at a given temperature being in proportion to the extent of the surface it offers to the air; in the more powerful action of the flame on the bottoms of the boilers; in the economy with which they are capable of being set, and in their durability.

Whether the boilers be constructed on the plan just given, or on the old plan, it is very desirable to have an effectual provision made for conducting off the vapor from the surface of the boilers,—the free access of dry air to the surface of a boiling fluid being indispensable to a rapid evaporation. Those buildings are the driest in which the roof is not sharp, having in them wooden chimneys about fifteen inches wide over the middle of the whole line of boilers, and a roof descending inside of the house from the upper side of the opening, down to within three and a half feet of the top of the masonry, and out as far as its front edge, being furnished with a spout all round for leading off the water which condenses from vapor, previous to its escape from the chimney. Where the distance is too great from the surface of the kettles to the opening in the roof, the aqueous vapor condenses and the temperature of the air is constantly too low to favor a rapid ascent of the steam. So important, indeed, do we regard this object of having the boiling room dry, that we would suggest the plan of carrying a steam pipe along the rear of the kettles, just above their surface, in order to rarefy the air over the kettles, and to promote the expulsion of vapor through the chimney.

The syrup being brought to 25° B. while hot, is to be withdrawn to a large wooden reservoir, capable of holding 1,000 or 1,500 gallons, and whose depth should be at least three feet.

With respect to the remainder of the evaporation, we have three processes to recommend, viz: 1. The Bascule Pan; 2. The Bascule Pan with Kneller's Blowing Pipes; 3. The Vacuum process.

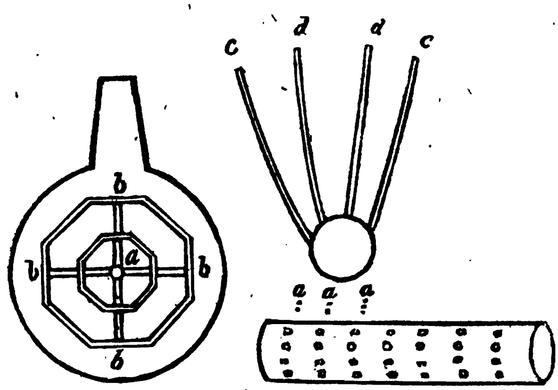
The first of these, already in pretty extensive use in Louisiana, has over the kettles, the advantages of completing the operation with greater rapidity and safety,—of enabling the operator to carry the boiling completely to the point of granulation, and then to decant the whole charge instantaneously into the cooler;—also of giving to the syrup time for depositing a heavy sediment of impurities, not otherwise separable from it, but which, on the old plan, goes forward to impair the granulation, and to discolor the Sugar; and, finally, of allowing the sugar boiler to superintend in person, the concluding and most delicate part of the manufacture—one bascule pan being sufficient to evaporate to the granulating point in 12 or 15 hours, all the juice which two sets of kettles can evaporate to 25° B. in 24 hours.

But the bascule pan, with all its advantages, still allows of a very considerable deterioration of the syrup, in consequence of exposing it to so high a temperature as 234 or 240°. To avoid this difficulty, the

bascule pan with Kneller's blowing pipes, is highly deserving of the attention of the sugar planter; and will probably be found to embrace all the advantages which he can expect in this branch of the manufacture, unless, indeed, he has the means of adopting the vacuum pan.

The object of the blowing apparatus is to supply to the heated syrup, numerous currents of air, which, by promoting evaporation, have the effect to keep the temperature of the liquid considerably below the boiling point of water. The principle, as applied to this subject, has been proved, by Mr. Penny, of Donaldson, sufficiently to establish its advantages. He found that while the evaporation was very rapid, it was yet impossible by means of high steam introduced into a shallow chamber beneath his boiler, to raise the temperature of the syrup higher than 180°.

The tubes made use of for delivering the air to the pan, are of tinned iron, or sheet tin. The annexed Figure represents their position in the pan. They form two octagons; the outer one within eight inches of the sides of the pan, the inner one, one foot from the centre. The diameter of the tubes is four inches. They are connected by the cross tubes, which are two and a half inches in diameter, and which radiate from a central pipe six inches in diameter, a horizontal section of which is seen at a. The wind passes down the large perpendicular tube, and radiates by the smaller pipes into the octagonal series, from whose lower surface it is forced through long quill-shaped tubes to the bottom of the bascule pan. A section of the pipe, forming the octagonal series, is shewn in the annexed figure, having the under side uppermost: it shows the quill pipes, which form four rows in the direction of the length of the pipe. The third figure represents the holes in the bottom of the tube into which the quill-pipes are inserted. The distance between the cross-rows a, a, is four inches, the length of the exterior pipes c c is eight and a half inches, the interior ones seven and a half. They are three-eighths of an inch in diameter at their insertion, and taper to one-eighth of an inch at the opposite extremity. The smaller radiating pipes, between the centre and the first octagon, give off from their lower side, two rows of similar quill pipes.




The perpendicular tube rises six feet from the top of the pan, and embraces, at its upper end, another tube of smaller diameter, to which it is fitted by a stuffing box, so that by ropes attached to the horizontal pipes and connected with pulleys above, the apparatus can be lifted perpendicularly five feet above the pan,—the larger tube slipping over the smaller one, as the machine is elevated. The smaller tube, at the height of ten or twelve feet, turns at right angles, and runs off to the blowing machine, situated in the lower part of the mill, or engine-room.

But, as the orifices of the pipes would be liable to become closed, if they touched the bottom of the pan, the octagonal series of pipes stand on four iron feet, situated at the extremities of the smaller conducting pipes, at b b b b. These legs are of such a length as to bring the wind-pipes within two or two and a half inches of the bottom of the pan.

The blowing machine may be constructed as follows:—Provide two wooden cylinders, firmly made of staves, one and three-fourths inch thick, and well hooped with iron. The diameter of the cylinders should be two feet four inches and their length two feet eight inches. Each of the cylinders must be furnished with pistons, lined with sheep skin having the wool on, the piston rod being of wood, seven inches in diameter, and about ten feet long, connected with the extremities of a wooden beam fourteen inches square, and about fifteen feet in length, whose centre is balanced on an iron pivot. An arbor, turned by the steam engine, gives motion to the beam, which lifts and depresses the pistons alternately. The wind is forced from the cylinders by means of tubes leading from their bottoms into a third cylinder, situated midway between the two. The top of this cylinder is moveable, up and down, and is maintained in a horizontal position by a frame above, which fits a groove on each side, made into two uprights, rising two and a half feet above the top of the cylinder. It is from this vessel that the air is conducted to the blowing pipes; the force of the current being regulated and rendered uniform by weights placed upon the top of the cylinder.

The whole expense of the blowing apparatus will not exceed one hundred and fifty dollars. The blowing machine here recommended, is like that employed by Mr. Penny, and which cost him one hundred dollars. He paid for the blowing tubes, in New Orleans, twenty dollars: his tubes, however, were adapted to a rectangular vessel, and may, on account of greater simplicity, have been afforded somewhat lower than the arrangement above described.

A roof should be constructed over the pan, to facilitate the escape of the vapor, as in the case of the boilers above described.

The bascule pan should not be filled to a depth greater than five inches; and the blowing pipes should not be lowered into the syrop before it has nearly reached 200° F. To prevent portions of the syrup from being thrown out, by the agitation of the fluid, a temporary border may be attached to the rim of the pan, so as to increase the height of the sides four or five inches.

The striking point is determined, by examining, from time to time, the granulation on the spoon, and by the length of the thread formed between the fingers. When the syrup attains the proper point, the pipes are elevated by the pulley and cord, and a thermometer is lowered into the pan; and immediately on the rise of the mercury to 200°, or, in some instances, to 206°, the contents are discharged to the coolers. The sudden heating of the syrup, after the granulating point has been reached, is necessary, to prevent a confused granulation in the coolers. It melts the grains which had formed in the pan, under less favorable circumstances, and by the fluidity which the heat imparts to the gummy matter, the obstacles to a recommencement of granulation, are less, than at an inferior temperature. The degree to which this heat must be carried, whether 200 or 206° will depend upon the ripeness of the juice, and its consequent freedom from gum.

The vacuum process is, undoubtedly, the most perfect method ever yet devised for completing the concentration of the syrup, inasmuch as the boiling goes on, away from the air, and at a lower temperature than in the bascule pan, even when furnished with Kneller's blowing tubes. But against it, exist the objections of the first cost of the apparatus, its liability to derangement, and the considerable supply of water which it requires. It is asserted, however, by those who have tried it, to be, notwithstanding these draw backs, (to use the French word) the *perfectionement* of the art of sugar making; and theory, also, would seem fully to justify the assertion.

For the illustration of this improvement, we shall first offer such accounts concerning its operation, as have reached us from Demerara, together with descriptions of the apparatus published by Messrs. Wm. Oaks & Son, the manufacturers of it in England.

*Description of the Apparatus.*

The syrup is conveyed from the kettles, by a trough, into the receiving cisterns, D D, Fig. , from whence it is drawn up into the vacuum pans, E E, by the feed cocks, b b, by opening the valves, c c, which communicate by the stand pipe, d, to the air pump main, e. When sufficient syrup is taken into the pans, which is ascertained by the floating guage, F F, the feed cocks are turned off, when a jet of cold water is admitted by opening the injection cock, g, which supplies itself by the main, h, from its cold water cisterns of the engine, or any other reservoir, which condenses the vapor as it evaporates from the syrup, and the condensed water and air are drawn off by the main, k, by the action of the air pump, l, which is worked by the steam engine, L, (or the machine may be worked by water or cattle, in situations unsuited to a steam engine.) When a partial vacuum is maintained in the pans; and when a sufficient quantity is taken into the two pans to make one filling of the heater, G, and the barometer stands at 26°, and the sugar boils rapidly at 150°, or 155° F. the sugar then is sufficiently granulated; which is proved, also, by an instrument termed a proof-stick, (m,) by which they occasionally ascertain the progress of concentration; for, upon attaining a strong grain by the first charge in the pan, depends the increased grain, until the whole is at proof, (which is about six charges,) when the sugar is discharged into the heater, G, and the temperature of the whole contents raised to 180° F. where it acquires a large brilliant grain.

Ths sugar is then removed into the pneumatic pans, H H, where it is thoroughly cured, and then it is placed in trays in the drying room, heated by steam, by opening the valve, n, which supplies the main, o, where, in three days after, it is perfect for packing and shipment. Thus, from the crushing at the mill, till the proof is complete, is four days.

P, is the valve to admit the steam to the pans and heaters, and is always on the main, g, during the day's boiling; r is a cock in the educting main, k. By closing the descending stroke, of the air pump, it may work the vacuum frame, and the ascending stroke, the pneumatic pans, whilst opening it, and arranging the valves, c c, of the vacuum pans and the valves s s, of the pneumatic pans; accordingly, the pump will work either the vacuum or pneumatic pans at pleasure, with double action. K, is the steam boiler, with its requisite apparatus, of sufficient capacity to com-

mand the vacuum pans, heaters and drying room. The pressure used is six to seven pounds. L, is a portable condensing steam engine, upon the simplest construction, and being of five horse power, is sufficient to govern the apparatus; for it has been found advisable to have the apparatus as distinct from all other machinery as possible, excepting the air pump, which may be attached to any power in motion: if the sugar mill is worked by steam, there may be sufficient power to spare, to work the air pump, and steam enough from the boiler in operation, to supply pans and heaters, in which case it may be employed. t, is the general steam main; u, is the supply cock to the trough; v, the main, to feed evaporators from the receiving boxes in the mill house. u u, the cocks for drawing off the syrup in the bottom part of the pneumatic pans. x x, troughs to convey the sugar from pans to heater G. y y, levers to play to discharge pans. z z, air cocks to pans. No. 1, condense water main to syphon. 2, connecting arms from pans to valves c c. 3, main holes to pans. 4, cocks from main to steam out pans. 5, a small cock to destroy vacuum previous to discharging the pans. 6, supply to feed head from hot water pump of engine. 7, a safety pipe.

Such is a general outline of the apparatus. Each pan evaporates about 50 gallons per hour. The pneumatic pans are vessels furnished with false bottoms of metallic guaze, upon which the Sugar is spread in thin and equal layers, the air being extracted beneath the false bottom by means of the air pump, when the pressure of the atmosphere upon the upper surface forces out the fluid parts, and leaves the crystals in a state of perfect purity. These pans, however, are not constantly resorted to for draining: but the Sugar, after having been heated to 180° F. in the receivers, called the heaters, which are surrounded by steam, is put into very shallow vessels, to drain off small portions of uncrystallizable syrup adhering to it, when it is placed in trays and dried in the sun, or removed to the drying house heated by steam, where it is occasionally stirred to promote the curing.

It is stated that the Sugar thus manufactured yields twenty-five per cent. more than in the old process; and that it commands an additional price of about two dollars the cwt. A considerable quantity of the Sugar has been shipped from Demerara to Liverpool; and samples have been purchased in that city, indifferently, of retailers, and brought to this country, for comparison with the specimens sent out with the advertisements of the apparatus; and no preceptible difference is observable between the two. It is now lying before us in several samples; and is in perfectly transparent crystals, whose edges and angles are as sharp and well defined, as those of any of the most perfectly crystallizable metallic salts. They have the form of six-sided prisms terminated by two-sided summits, two of the opposite lateral faces being unduly extended, so as to give to the crystal a flattened, or flake like appearance. In size, they have sufficient dimensions to enable us to detect their form with the naked eye; and they may be said to vary from one-sixth, to one-eighth the size of a grain of rice. There is no pulverulent sugar, or molasses, adhering to the crystals; but they fall freely from one side of the containing vessel to the other, like crystals of common salt, or nitre. The taste and odor of this Sugar are a pure mellifluous sweet, surpassing any other raw sugar we have ever seen. A second quality of this

Sugar differs from the first, not in the size and perfection of the crystal, but in a slight dingy hue, which, in a small degree, impairs the transparency of the crystal.

The Sugar made in the vacuum pan has the advantage of greater weight in proportion to its bulk, or in other words, of a greater specific gravity. By actual experiments made on one estate in Demerara, four gallons of Sugar, made on the old plan, weighed twenty-four pounds; four gallons made in the vacuum pan, weighed thirty-two pounds:—giving a difference of eight pounds, or two pounds to the gallon. This is a result on the whole perfectly reasonable to be expected; inasmuch, as the greater the number of the fractures in a body, the greater is the number of interstices among them, and consequently the greater is the room required for the reception of the masses.

The following remarks from Mr. Thomas Dodson, the agent of Messrs. Oaks, in Demerara, were published in the Guiana Chronicle and Demerara Gazette. "The pressure of the atmospheric air on the surface of Sugar, or any other liquid boiling in an open vessel, counteracts the ebullition, and by thus retarding the evaporation, renders either an excessive heat, or a longer exposure to one less intense, unavoidable. The common operations of the kitchen afford us daily proofs of the effects of fire upon animal and vegetable substances, and their tendency to carbonize. Milk, for instance, exposed to a fierce fire, not only contracts color and a disagreeable taste, but forms a black and adhesive crust on the bottom of the vessel. Meat, fish, eggs, &c., possess this tendency in a greater or less degree; a certain portion of their substance is either entirely destroyed, or undergoes a chemical change, which leaves it little or no identity with the original mass of which it formed a component part. In the manufacture of Sugar in the teache, (battery) the destructive effects of excessive heat obtain to an extent beyond what may generally be suspected. It destroys a great proportion of the crystals, or what is the same, it converts the syrup, which would otherwise crystallize, into molasses, by which the quantity of Sugar is very materially diminished, and by the creation of carbon, or coloring matter, deteriorates its quality. By this two fold disadvantage, the planter is subjected to a great loss, from which, by the adoption of this system, he now possesses the opportunity of relieving himself.

"The excellence of the principle of boiling in vacuo, consists in the exclusion of the atmospheric air, and the consequent removal of its pressure; in being able to perform that operation at from 90 to 100° less heat than is required in an open vessel, at which temperature it cannot possibly sustain any injury in its crystals or its color."

It will appear, before the conclusion of this article, that the apparatus just described, is the same with that invented by Mr. Howard, for the evaporation of syrups in the refining of Sugar. We are not able to state definitely what would be the expense of this apparatus: we subjoin, however, the prices as quoted by Messrs. Oaks & Son, of some of the most important and costly parts of it. Two pans, with all appendages, £215 each, and two heaters, £70 each. They also give about £1,200 as the price of the steam engine, boiler and air pumps.

A modification of Howard's plan has been effected within a few years, which appears to be a very important improvement upon the first in-

vention. The alteration embraces both the construction and material of the pan. It is made of boiler iron; and is at least three times the capacity of Howard's pan. It bears some resemblance to the upper part of a steam engine boiler, supposing its horizontal section to be made considerably below the centre of the boiler. Its length exceeds its depth by about two feet. The steam is admitted to the interior of this vessel in such a manner as to increase the heating surface as much as possible, and an apron surrounds also the bottom of the pan, between which aud the bottom, steam is admitted: the consequence of the whole arrangement is, that evaporation goes on with the greatest rapidity; it can evaporate from 150 to 200 gallons in the short space of 15 minutes.

Trial of a pan of the above description has been made upon the estate of Mr. Thomas A. Morgan, just below New Orleans; and although the apron gave way when the pan was first put in operation, and notwithstanding the suction pipe which affords the water of condensation, is only half the requisite diameter,—still very encouraging results have been obtained. During ten days in which it was in operation, he made with one set of kettles, 100 hogsheads of Sugar, from cane juice below the average richness in saccharine matter; and the Sugar thus made, possesses a large, firm grain, and is believed to be worth, at least, one dollar per cwt. more than Sugar made in the open kettles. It was believed also that an increased yield of Sugar was obtained by the process. Mr. Morgan did not employ the heater for melting the Sugar in coming from the pan; but, as a substitute, he retained it in the pan after the working was completed without condensing the steam, until the syrup rose to 180°. His method of cooling and potting was the same as those in general practice.

In view of this experiment, we feel confident that the present apparatus, when employed under the most favorable circumstances, and with due attention to the defecation of the juice, and to the potting of the Sugar, will afford the same exquisite product, as is produced by the similar apparatus employed in Demerara.

Mr. Morgan has furnished us with the following particulars of the cost of an apparatus like his own, to be put up on a sugar estate in Louisiana; the list, without claiming to be any thing more than an approximation to precision, in the details, still covers the extreme cost of the apparatus, as a whole.

| | |
|---|---|
| Pan and connecting pipes, - - - | $2,500 |
| Air pump, - - - - - - | 500 |
| Condenser of iron cased with wood, - | 300 |
| Boilers and engine, - - - | 2,000 |
| Other fixtures and putting up, - - | 700 |
| | $6,000 |

Some embarrassment may be experienced in particular situations, in obtaining a due supply of water. Mr. Morgan, whose establishment is 1125 feet from the river, and 13 feet above it, still obtains his supply from that source. Sugar houses, more remote from a similar supply, might find an adequate substitute in the construction of a cistern, to be filled with water from the roof of the buildings.

It may be worthy of remark that evaporation by Kneller's plan (described in this report) is no where practised in American refineries. A single establishment in London is said to be worked after this method with good success. The great economy in the first cost, when compared with the vacuum pan system, renders it deserving of attention in our refineries. We should recommend that the pan be heated by steam in preference to a naked fire, as the condensed steam would be of constant use in such an establishment; and the arrangement would greatly promote the cleanness of the syrups. The pump which furnishes wind to the tubes, might, at the same time, work the pneumatic pans.

An apparatus has been invented in France for evaporating syrups in vacuo, which dispenses with the air pump and engine. Its inventor is Mr. Roth; and a description of it is published in the *Manuel du Fabricant et du Raffineur de Sucre, Paris,* 1833, of which we here insert a translation. It differs from the invention of Howard, not only by its form and construction, which are of great simplicity, but also in dispensing with the use of a steam engine, the vacuum being produced by the vapor. Founded upon other principles, it has nothing in common with the English apparatus, except the object of withdrawing the evaporating fluid from the influence of the atmosphere. Mr. Roth states, that it completely accomplishes the conditions of a vacuum; and boiling, at a low temperature, his process is more economical, more prompt, and offers a better form of working than the English method.

His apparatus is composed of a double bottomed copper boiler, covered by a dome or cupola of the same metal, and hermetically closed. The space comprised between the two bottoms is heated by steam from a generator, which distributes it equally under the cupola in order to produce the vacuum, and into a serpentine tube situated upon the interior bottom, where it circulates constantly, in order to effect the cooking of the syrop. As soon as the boiler is freed from air, and the vacuum is established in it by the condensation of the vapor, the syrup contained in a contiguous receiver, is let in through a tube furnished with a stop cock.

As soon as the vapor is produced in the boiler, it passes into a receiver, where it is condensed, by a current of cold water, which is scattered through the interior of the vessel in the form of rain. The water of condensation, warmed by the heat of the vapor, is employed for several useful purposes. The proof of the cooking depends upon the thread. A very simple sound, of convenient application, is fitted to the boiler, which allows of the removal of a small portion of the syrop without the admission of the air. After the boiling of the syrup is completed at the ordinary pressure, it is run off, by means of a tube, into an adjoining receiver. According to the author, it offers the following results:

1st. It works, with great rapidity, an apparatus, the boiler of which is six feet in diameter, and is equal to a refinery which manufactures 25,000 pounds of brown sugar per day. In order to cook this quantity on the English plan, it is necessary to employ four boilers of the same dimensions. The mean time required for the cooking of a charge is 15 minutes, which is an important advantage over the apparatus of Howard; for it is demonstrated that solutions of sugar, submitted to a long continued boiling, notwithstanding the feeble temperature to which they may

be exposed, lose more or less their property of crystallization. M. Roth has ascertained, by experiment, that even in a vacuum, syrups when subjected to a long ebullition, are not exempt from this kind of alteration.

2. The temperature at which the boiling takes place is 63° R. It is possible to boil at a lower temperature, but it would not be attended with any advantage. Three circumstances affect the temperature of the boiling; 1st. The quantity of matter forming the charge of the boiler; 2ndly. the tension or density of the vapor; 3rdly. the volume of water admitted into the apparatus to condense the vapor. By diminishing, on the one hand, the charges of syrup and the degree of pressure of the vapor, and in augmenting, on the other hand, the volume of the water, it is posssible to depress the thermometer to 55° R., or even lower; but the most convenient limits are 60 to 65° R.

3d. In this system, heaters are not employed on the plan of Howard; but instead of them, at the close of the operation, the charge is left in the boilers, a few seconds, exposed to the pressure of the steam, when it comes out at 70° or 72° R.

4th. The new apparatus, worked by low pressure steam, (about a quarter of an atmosphere above the ordinary pressure,) avoids all the inconveniences and dangers connected with the use of steam in the ordinary heaters. Nevertheless, the low pressure is not indispensable. The apparatus works also by means of high pressure without the occurrence of any alteration in the essential particulars of the system; still a low pressure is preferable, especially in cooking low syrups. A more elevated tension in the heating steam, hastens the operation of the machine.

5th. By means of this system, syrups of the lowest quality can be cooked, the working of which, on the old plan, was attended with insurmountable difficulties.

6th. The inventor, founding his assertions upon several considerations, asserts that his system is economical in point of fuel. 1st. The heat is concentrated in a single fire: 2d. Its application is vastly more advantageous in furnaces where the flame has a longer circuit to traverse, than in boilers hung over naked fires, where the flame strikes only a small surface before losing itself in the flue of the chimney. 3d. The quantity of water which may be reduced to vapor with a given quantity of fuel, is much greater in heaters with low, than in those with high pressure steam, and the loss of heat through the containing vessels, is less in the first case than in the second.

7th. Another advantage arises from the perfect condenation of all the vapors with which the apartments of sugar houses are generally filled, and which tend to promote their decay.

8th. It is never necessary to scour the inside of the boilers. At the temperature under which the boiling takes place, nothing can attach itself to the heated surfaces in contact with the liquid. The introduction of steam into the interior of the boiler, is sufficient to wash those surfaces, and to keep them always neat.

9th. The fundamental advantage from the evaporating system of Mr. Roth, arises from the products obtained. These are superior as respects color and taste; and the quantity of uncrystallizable residue is diminished in a very notable proportion.

*Explanation of the Figures.*

Fig. 9, lateral elevation of the apparatus, and section of the receiver for the condensation of the vapor.

Fig. 10, perpendicular view of the apparatus.

Fig. 11, spiral tube, or worm placed upon the upper bottom of the boiler.

Fig 12, horizontal section on a level with the dome of the receiver for vapor.

Fig. 13, section of the sound for trying the syrup.

Fig. 14, the piston of the sound by itself.

Fig. 15, section of the tube in which the piston works.

The same letters indicate the same parts in the different figures.

A, copper boiler for evaporation; it is formed of the following pieces: a a, inside bottom; b b, double bottom, or outside bottom.

c, cupola. These three parts are united by a common joint.

d, top, fitted with a well adjusted cover.

In the interior of the boiler is placed a serpentine or worm, formed of a copper tube, e, fig. 11. This worm rests upon the inside bottom, a a, at the height of the place of junction of the two bottoms, and of the cupola.

B, receiver of sheet iron.

f, head of the receiver; g g, a species of calender, formed of a copper cylinder, whose surface is, every where, pierced with holes. In its interior, is seen a series of plates, or diaphrams, h h, superimposed one above another, and equally pierced by a great number of holes.

i, level of the water.

k, thermometer.

C, copper ball.

D, a receiver of known capacity, and equal to the charge of the boiler.

E, reservoir for cold water.

G, wooden frame for the support of the boiler.

H, masonry which supports the wooden frame.

I, tube, with triple branches, for admitting steam from the generator into the apparatus.

J, tube, conducting the vapor of the boiler A, into the receiver B.

K, tube, plunging into the receiver, D.

L, tube, descending into the receiver, E.

M, thermometer, which enters the boiler, A.

N, sound, for taking samples from the boiler.

O, tube, for the discharge of the water of condensation.

l, stop cocks, for the admission of vapor into the boiler.

m, do. for the outlet to air, and afterwards for the water which has served for condensation.

n, lever key to this stop cock.

o, stop cock, for the admission of the syrup into the boiler.

p, do. for the introduction of steam into the double bottom.

q, do. to let the steam into the serpentine tube, e.

r s, do. for the return of the steam.

t, do. for respiration.

u, do. for the admission of the air.
v, do. to empty the boiler.
w, pistons of the sound, N.
x, body of the sound.
y, conical part of the cistern.
a, corresponding cavity of the cylinder. X.
b b, small air stop cocks, fitted upon the return stop cocks, r s.
c, cylinder stop cock.

*Manner of operating.*

The first thing to be done is to drive out the air. In order to accomplish this, steam is admitted to the boiler by opening the stop cock, l; the air passes out by the stop cock, m: its expulsion is complete in a few minutes, one or two for example. It is perceived when the vacuum is formed, by touching the lower part of the receiver, B; when the stop cock l and m is closed, and s is opened. The syrup from the receiver, D, is drawn rapidly into the boiler, under the influence of the vacuum which is formed by the condensation of the vapor. The stop cock, o, is reclosed before the level of the liquid in the receiver, D, discloses the orifice of the plunging tube, K. At this moment, it remains only to introduce the vapor into the double bottom, and into the tube v, by means of the stop cock p and q, and to open the return cocks, r s, fig. 10. These cocks return to the generator, the water coming from the condensed vapor: they each have a lateral branch, furnished with a small air stop cock.

A few seconds after the introduction of the vapor into the spiral tube, and into the double bottom, the float of the thermometer, k, rises, which had descended, at the time when the syrup entered the boiler. This indicates that the syrup has attained the point of ebullition. The respiration cock, t, is then opened; this regulates also the admission of the water to the reservoir, so as to maintain the float of the thermometer within fixed limits.

When it is judged that the operation is near its completion, a trial is made of the syrup by means of the sound, N. This instrument consists of a copper cylinder, presenting, without, a conical entrance. It raises a piston, w, of copper. The stem of this piston bears, below its handle, a cone, y, adjusted to the socket, which forms the entrance to the body of the cylinder or pump. A little cavity, z, hollowed out of the piston, corresponds to a channel traversing the body of the pump. When the piston is thrust to the bottom, and turned, so that the channels coincide, the syrup flows into the cavity. The use of the instrument consists in turning the piston half round, by pressing upon the handle so as to bring the cavity uppermost. In this semi-circular movement, the piston closes the cylindrical stop cock, c. The piston is then withdrawn, and having taken the proof in the cavity full of syrup, it is replaced in its former position.

The syrup being cooked, the workman closes the stop cocks, p q r s t, and having permitted the air to enter by the stop cock u, he simultaneously discharges the boiler by the stop cock v, and the receiver B, by the stop cock m, in order to commence another operation.

The ball, C, seems to effect, instantaneously, the condensation of one

part of vapors, which fill the apparatus immediately after the expulsion of the air, and to induce the speedy rising of the syrup in the boiler: it is especially useful, when the receiver, D, is situated at a distance from the boiler, and when the syrup, in order to reach it, is forced to mount a certain height. The height of the rise of the water ought not to exceed five or six *mètres*.

Other forms of apparatus, arriving at the same end with the above, have been invented; but that of Mr. Roth enjoys the superiority among them. No application of it, that we are informed of, has yet been made, either in the West Indies or in the United States; and we have yet to learn what practical advantages attend its employment in France.

*Fuel.* It has been already stated, that between two and three cords of wood are consumed in the fabrication of a hogshead of Sugar. No attempt has been made to employ the bagasse in sugar boiling, if we except the occasional use of it in Georgia, in a wet state, to damp the fire under the kettles during the transfer of the syrup. Nor is it surprising that, in Louisiana, this material has been neglected, inasmuch as the clearing up of their swamps has, until within a very few years, afforded them an abundance of wood. But the time has now arrived, when the increasing distance of the wood, renders it expensive to the planter; and, moreover, such is the demand on the river for fuel for steamboats and other purposes, that the wood, when taken to the bank, commands such a price as to induce the planter to seek, at least in part, a substitute for its use, in his sugar works. This is not the case, however, in Georgia and East Florida, where an abundance of pine wood for fuel is readily obtained; and where the bagasse is employed to great advantage for manure. To many of the planters of Louisiana, therefore, it is strongly to be recommended to turn their attention to this new source of fuel. Not a doubt can be reasonably entertained, that it would completely supply the furnaces for the kettles, and even the fire for the engine boilers, in part. Some persons have expressed doubts upon the subject, arising out of the consideration that, as the cane does not arrive at the same maturity in Louisiana as in the West Indies, the bagasse will, in this country, prove on that account, less valuable as a fuel. But it is believed, that wherever the cane is ground in steam mills, and its juices thoroughly expressed, that the same weight of West India bagasse, will go no further than that of Louisiana; and even where mills with animal power are employed, the difference will be only, that the more drying will be required than in the other case.

That the bagasse will enable our sugar planters wholly to dispense with wood fuel, we do not believe, inasmuch as the cane liquor of our country is so much more dilute than that of the West Indies; but if two-thirds of the boiling can be done by this means, and several acres of valuable land in the vicinity of the sugar house, thereby redeemed from being uselessly covered by the bagasse, it surely must appear to be an object worthy of attention.

The bagasse houses at Demerara are high one story buildings, 30 to 35 feet wide, and from 100 to 200 feet long. The walls consist of brick columns about eight feet apart, which are larger at bottom, where they are hollow. These columns are perpendicular on the inner side, but slant outwards as they approach the ground. The roof rises from a wooden frame, supported by these columns, and is traversed its whole

extent on both slopes with "cow-mouth" openings, to allow of the escape of air, and to prevent the access of rain. There are doors also at the end of the roof. These buildings are placed endwise to the direction of the prevailing winds of the country, and at a distance of about 200 yards to the leeward of the mill. There are two rails laid down from the mill room, which lead through the bagasse house, upon which cars move for the transportation of the wet bagasse. A laborer is stationed in the house, who unhitches the loaded car, and attaches the unloaded one to return for a new load, while he unloads that which has just arrived. In unloading it, he throws the bagasse quite into the roof. In about ten days, it undergoes fermentation and becomes much heated, sometimes pressing the walls outward with great force; and in about twenty days it is ready for use. They commence using from the end of the house first filled. The dry bagasse is carried to the furnaces in bundles on the heads of two laborers, where the fire is fed by a third. When pressed for fuel, they dry the bagasse in the sun, where it becomes cured in six days.

*Striking Point.* This we believe must be determined by the appearances offered by the syrup, when lifted into the air in small quantities, and when drawn out in thread between the fingers. The thermometer may serve to inform the operator when the point is approaching, but can rarely be trusted to for fixing it altogether. And so easy is the acquisition of the requisite skill for this determination, that improvement in this part of sugar making seems almost unnecessary. If any difficulty occurs, it can be only in the night, when the deceptiveness of the light, or excessive sleepiness occasionally leads to errors. But in the system of boiling recommended in this report, the final concentration of syrup is performed wholly by day light.

*Coolers.* The present system of coolers in Louisiana and Georgia appears to us seriously defective. Three and four strata of sugar, placed one upon the other, each containing its own molasses, form a mass which, when introduced into the hogshead, is illy adapted to thorough draining. Besides the strength of the granulation is impaired by the shallowness of the stratum formed by each skipping.

A great variety of trials has been made for the improvement of coolers, attended with various degrees of success. Mr. Penny, of Donaldson, after many experiments, expresses himself well satisfied that no improvement upon that suggested by Dutrone, is practicable. Mr. Stockton, of Georgia, has fully adopted this mode; and it was with him that we had an opportunity of observing its decided superiority over every expedient which we have elsewhere seen in operation. As this is a plan of whose superiority, we are thoroughly convinced, we shall transcribe Dutrone's description of it, as given by Porter,—adding, in conclusion, a few suggestions affecting its convenience in minor particulars.

"The curing house on the plan under consideration must first be described. The buildings for the curing house, Fig. 17, ought to be very large, and built on the same line, to save labor; and that every thing which is passing in them may be seen at one view. There are several rows of vessels for crystallizing, Figure 17, placed upon channels R, which terminate in the cisterns L, M, N, O. These vessels ought all to have the same form and capacity. A certain number, commonly four, are selected to receive the concentrated syrups, as

# PART II.

## REFINING OF SUGAR.

### 1. *By Steam, and the Vacuum Process of Howard.*

In treating of the art of sugar refining in the United States, it may be said that all the refineries except three, are established on what is called the old method, by which is understood the method of evaporating in open pans. Indeed, very few have abandoned clarification by blood, and the use of clay. The three exceptions to the old system, are the Congress steam refining company of New York,* Messrs. Lovering & Canby's house, of Philadelphia, and the New Orleans Sugar Refining Company.† These are all worked upon the vacuum plan, originally invented by the Hon. Charles Edward Howard.

We shall first describe some of the most prominent features of the new method; after which, will follow accounts of the old method as practised in the United States.

The object of refining sugar is, to obtain from the raw material as much as possible of crystallized sugar, free from the syrup, and from coloring, earthy, acid, and other matters with which, in that state, it is mingled. The greater part of these foreign substances are in a fluid condition, adhering to the exterior, and filling little cavities within the crystals of the sugar; and as their solubility is very great, if the sugar is placed in an advantageous condition for draining, a large portion is got rid of in this way; thus for example, if the raw sugar, previously moistened with water, be thrown into large conical forms and heated to 190° or 200° F. the uncrystallized foreign matters, from their superior gravity and fluidity, subside to the bottom of the form, and when the contents are cold, they may be drawn off by opening an orifice at the bottom. The sugar in the form will now have nearly a uniform degree of porosity, but will still contain a large portion of discolored syrup, especially towards the lower part of the form. By pouring water upon the top of the form, another part of the syrup and impurities would be carried down; but so open is the upper stratum as to permit the water to flow through with too great rapidity; by allowing which, before the desired purity should be attained, too much of the sugar would be dissolved, and drained off, along with the syrup. Accordingly, the upper portion of the form being pared off, and mixed up into a magma of such a consistency as will not readily allow of its closing behind the stirrer, may be replaced on the even surface before prepared; and as soon as it becomes moderately dry,

* The operations of this company are, as we understand, suspended.

† A second vacuum pan house is about commencing operations in Philadelphia.

a saturated solution of fine sugar in cold water may be poured upon it about half an inch deep. This syrup, in descending slowly through the form, will entangle the heavy impurities lodged among the grains of sugar, and find, with them, its way to the bottom of the form.

The ordinary process of refining by Howard's patent, as improved by Hodgson and others, may be described as follows:—The raw sugar is first put into a melting pan surrounded by steam, that will not heat it above 180° F. when it is mingled with a small quantity of water, enough to make it sufficiently thin without the grain of the sugar being dissolved; and being well mixed, it is poured into moulds, and being up stairs one day, they will, each, run three quarters of a pot of thick syrup. They are then scraped off, as though the lump was nett; and the loose sugar removed from similar lumps of former refines, is well broken up and mingled with water to the consistence of green clay, when it is poured on to the pared off faces. This magma (three pints or two quarts to a form) will pass through in twenty-four hours, and is again repeated the next day, which will render the meltings (as they are called) nett, or of one uniform appearance from the face to the tip. In undergoing this operation, the meltings are said to receive their own liquors. After standing two or three days to drain, they are fit for clearing. They are then put into a cistern, called the *clearing cistern*, which has a steam pipe at the bottom, pierced with holes to allow the steam to escape and mingle with the sugar in the cisterns, until it is diluted to about two of sugar and one of water. The solution is well boiled by the steam, when a certain portion of animal charcoal and of Howard's finings are added, usually about 3 p. c, of the former, and 15 p. c of the latter.* The syrup, after this addition, is raised to a slight simmer and the first scum removed; when it is let into the filter, which is situated in the next story below and directly under the clearing cistern. The external part of the filter is a strong box; it contains a great number of filtering frames, which are covered with a kind of Russia duck, or cotton cloth. The frames are arranged vertically; they are made of tinned copper, crimped, so as to present vertical grooves on each side against the canvass, which is made into flat bags, with a hem about an inch broad and one-eighth of an inch thick, all around the mouth of each bag, and a frame is put into each bag to distend it. The distended bags being put into the filtering box, with their mouths downwards, and all the hems pressed tightly together, the fluid percolates from the outside of the bag to the inside, trickles down the grooves, and runs off by a cock. The pans prevent the turbid liquor from running down outside of the frames, and, at the same time, serve to keep the bags at a small distance from each other. (For a detailed account of the filter, see the Jan. 1828, number of the Repertory of Patent Inventions.) The syrup, at an elevated temperature, and aided by hydrostatic pressure, traverses the filter, whence it flows perfectly clear and bright to

* These finings are made by dissolving two and a half pounds of alum in twenty-four pounds of water for every cwt. of solid sugar that is to be refined, adding to such solution, about three ounces of whiting for each two and a half pounds of alum, and adding this to a cream of lime, the lime being in such proportion, that paper stained with tumeric shall barely change color by immersion in the mixture, recovering its former yellowness when dry.

the receiving cistern. From the receiving cistern, it is conveyed by a pump, or otherwise, to what is called the measure of the vacuum pan, and after having been let into the pan, and reduced to the proper consistency, it is discharged into the heater, which is a double bottomed pan, similar to the melting pan, and which is filled in three skippings: from this, after it has been heated, to 180°, and properly stirred, it is filled out into such moulds as the kind of goods intended may require. After being left a few hours in the fill house to cool and settle, they are pulled up, the stoppers removed, and the forms placed on pots to undergo the operation of making nett. This is effected in the same way in which the meltings were rendered nett, i. e. by liquoring; only, the magma is made of refined sugar. The advantages of liquoring over claying, have been clearly ascertained; they consist in a great saving of time, prevention of waste, the production of less molasses, and of Sugar of a superior quality. The specific gravity of the magma for liquoring fine goods, is according to the strength of the Sugar to be liquored: if it is free, the magma is thicker; if close, it is thinner. The quantity of magma for loaves is about one and a half pint each; for lumps, from one quart to three pints. The liquor is always made from a sugar, equal, if not superior, to the goods liquored. The liquoring occupies three days. The loaves are ascertained to be nett by knocking out one or two of each day's work. When nett, they are removed to a stove heated by steam, in which they are more equally and thoroughly dried, and the coat is rendered fair and sparkling. The goods made in this way are ready in twenty days, and are equal to a common double refine loaf,—having a peculiarly bold grain that cannot be acquired on the old plan. It possesses, also, a remarkably pure and delicate sweetness; attributable, in part, to the operation of the air pump, which removes all remaining portions of volatile matter, which is not got rid of, on the old plan, not to mention the freedom of such sugars from all taints, derived from the blood and eggs of the old system.

Good raw sugars are refined, also, without resorting to the preliminary process of melting; the Sugar being thrown, for the first step, into the clearing pan or cistern, and diluted by steam, to two of Sugar and one of water. They are rendered nett, as above, by the system of liquoring.

A most expeditious and highly ingenious course is taken, on the other hand, with low sugars, in order to avoid melting. The apparatus employed for this purpose, has been called the Pneumatic apparatus. With the valve of an air pump, worked by the steam engine, is connected a system of suction pipes leading to double bottomed cisterns, having surfaces of four or six square feet; the upper part of the box is occupied with the raw Sugar, upon which a float of syrup has been introduced. The exhaustion of the air from the bottom of the pan, occasions a current across the Sugar, which forces the syrup through holes in the bottom. This mode of extracting the syrup, is economical; and can be carried to any extent, which is unattainable upon the usual method. It leaves the Sugar nearly as pure as when it has passed through a refine. This method is attended with a great saving of time, compared with that of meltings, above described. It also dispenses with much room; with the use of moulds and with considerable labor. Each pneumatic

cistern holds one hogshead; and the operation is performed in from three to five hours, according to the per centage required: but the syrups thus obtained, require to be immediately boiled to prevent loss from acidity.

The temperature at which the Sugar is drawn from the vacuum pans is from 150 to 155°; that for granulation in the heater, 175° to 180°. The heat of the house is generally 70°, and the stove is maintained at a heat of 130° or 140° F.

A two pan house, on this system, not including the pneumatic apparatus, would cost about £2,500 sterling; the various parts of which would cost as follows: two vacuum pans, with appendages, £215 each, a melting pan, £115, two heaters, £70 each, two filters, £80 each, three sets of filter leaves, £300, three clearing cisterns, £110 each, three receiving cisterns, £40 each, which, with the steam engine, boiler, and air pump, will make up the sum of about £2,500 sterling.

Two heaters are sufficient for four pans. The clearing cisterns hold from thirty-five to forty cwt. each; and the charge is got off in from four to five hours, the operation being performed twice in one day. A two pan house, on this plan, is equal to a four pan house of the old system of working, and will require a steam engine of four horse power, which will be sufficient to work the air pump, and to supply the house and tank with water.

It is recommended to have two boilers, to be used and cleaned alternately; and in case of repairs being necessary to one, not to be obliged to stop the working of the house. Each boiler ought to be six times the size required for the engine, so as to be capable of supplying engine, utensils, house and stove. The pressure of steam is usually six pounds.

The quantity of water required for injection is 350 gallons for each pan, per hour, which supplies itself from the action of pump. For the engine, five gallons per minute, for each horse power, are required.

The quantity of water needed on this plan of refining, is at least twelve times greater than on the old mode, and demands for its regular supply, a main spring well; or if a land spring, a reservoir that will hold full 20,000 gallons, which, in case of necessity, could be supplied from the injection of the engine. Ten hours work require 19,000 gallons. The consumption of fuel is about eight chaldrons for six days, arranging the time at eighteen hours; or two and a half bushels each hour, for a two pan house.

Two vacuum pans, of the ordinary size, will each refine, with ease, two and a half tons per day, during the ordinary time, say nine or ten hours, giving five days refining, and one day bastards. The total expense of refining in England, including all incidental expenses, and interest on capital, with liberal management is 5s. 6d., with economy 5s. 3d. to 5s. per cent.

It is, at once, apparent how superior in dryness, ventilation and cleanliness, a house on the vacuum plan must be to one on the old mode. The facilities arising out of steam, in all the operations of handling the goods, heating the stove, dissolving the sugars, and maintaining the rooms at the requisite temperatures, are very great; while it requires but one furnace to the house, which is without the building, thus greatly diminishing the danger from fire.

The operation of the animal charcoal upon the syrup, depends upon the affinity which it has for coloring matter, with which it combines,

without effecting the decomposition of the latter. The finings, which consist chiefly of albumen, have the same effect, though their action is less energetic.

The reason why animal charcoal is preferable to vegetable, is, that its particles are more comminuted, the bleaching effect being in proportion to the surface presented by the charcoal.

A very decided improvement has been made in the application of animal charcoal, by first removing, through the intervention of an acid, the earthy and metallic matter, which it contains. Animal charcoal contains

| | |
|---|---|
| Phosphate of lime, Carbonate of lime, Sulphate of lime, Sulphuret of lime, Sulphuret of iron, Oxide of iron, | 88 |
| Siliceous carburet of iron, | 2 |
| Carbon, | 10 |
| | 100 |

These foreign substances communicate to the syrup a disagreeable taste, and impair its transparency even after filtration. Upon this subject, we cannot do better than translate a memoir upon the use of animal charcoal for the decoloration of syrups, read to the Pharmaceutical society of Paris by M. Blondeau, June 15, 1825.

"The sulphurets of lime and of iron must certainly contribute to impart to syrups the disagreeable taste which they have, after having been treated with animal charcoal. But it is, doubtless, in many cases, a portion of undecomposed animal matter, that deteriorates the beauty of the syrup, to get rid of which, demands our attention. Acids, which form with lime soluble salts, succeed perfectly for this purpose; and it is known that refiners and confectioners are in the habit of adding to the pan, when the syrup is nearly cooked, a certain portion of concentrated acetic acid, which causes the clarification to take place very effectually; but the syrup retains the salts formed by the acid, and the pharmaceutist who should employ this process, would not obtain a product of sufficient purity."

"Acetic acid has always been so dear, that I was led to attempt its replacement by muriatic acid, although I had heard of its having been used by some apothecaries, and that it had imparted to their syrups, a disagreeable taste. I have obtained myself, similar results, in conducting the process after the manner followed in the use of acetic acid.

"But in resorting to repeated washings with boiling water, I have prepared a syrup as fine and pure as that afforded with acetic acid. I now give precisely my method of operating. I take

| | |
|---|---|
| Animal charcoal, | 1 pound, |
| Muriatic acid, | 2 ounces. |

"After having reduced the charcoal to a paste, with a sufficient quantity of of water, I sprinkle it with the acid, accompanying the additions

with continual agitation. The charcoal swells up, and there is a disengagement of heat, and of a large quantity of sulphuretted hydrogen gas. I leave the acid in contact with the charcoal about an hour; after which, I pour upon it boiling water. The charcoal is deposited from the liquid very promptly; and the supernatant fluid is decanted. I repeat these washings three or four times; finally, I dry the charcoal by making it into little cakes, which are first exposed to the air, and, subsequently, to the heat of the stove.

"The drying of the charcoal is not absolutely necessary." "I now proceed to the decoloration and clarification of Sugar. I take of

| | | | | |
|---|---|---|---|---|
| Sugar, | - | - | - | 60 pounds, |
| Animal charcoal, | | - | - | 60 ounces, |
| Muriatic acid, | | - | - | 7½ ounces, |
| Whites of 6 eggs, | | | | |
| Water, | - | - | - | 18 pints. |

"The charcoal being washed, I make a paste with the coarsely powdered sugar and water, in which the whites of the eggs are beaten; I reserve about two pints of this water for the end of the operation. I place the basin upon a clear fire, so disposed that the bottom of the basin shall receive the direct action of the flame. As soon as the syrup enters into ebullition, I pour into it, in two or three additions, the albuminous water, which I had reserved, and after boiling, I take the basin from the fire, and leave the syrup to rest for a few minutes. I then receive the scum which is formed at the surface and pour the whole upon a filter of suitable capacity: the syrup which first runs, is turbid, which is returned, and when it begins to flow clearly, it is caught in another vessel. In a few hours the whole of the syrup passes the filter: and by the use of the most delicate reagents, it is impossible to detect in it a greater proportion of any muriate than is found in common well water."

The object of the filter in sugar refining, is not simply to separate the animal charcoal, but, in part, to prolong and to render general its action upon the liquid, which is promoted by multiplying as much as possible the points of contact with the liquid; it is also important to maintain it in a layer of a certain thickness upon the filter.

### *New Orleans Sugar Refinery.*

This flourishing establishment, already so well known for the extent and perfection of its manufactures, is situated about two miles below the city of New Orleans, within a very short distance of the river. The main building is five stories high, eighty feet long by forty wide, having a projection, at right angles to one side, which is four stories high, forty wide and about fifty long: these buildings have various extensive sheds about the two lower stories for the accommodation of engine, boilers, fuel, &c. It is surrounded, also, on two sides, the end toward the river and the side toward the town, with a continuous row of one and two story buildings, not less in all than 400 feet in length; these are occupied as store houses for raw and refined sugars, counting rooms, superintendent's apartments, and for tin, iron, and copper smiths' shops. In the rear, are houses for the accommodation of the workmen.

The buildings, which are of brick, are constructed with a good degree of economy and taste. Two rails are laid from the house to the pier, on the river bank, for the purpose of receiving sugars, coals, &c., the longest of which is 225 feet. The machinery and furniture of the house are almost exclusively of English manufacture. It is a four pan house; and is understood to be worked upon the latest improvements which have been made in sugar refining in Europe or America. It is furnished with a low pressure engine of forty-two horse power: and a second one was about being added, last winter. The boilers are heated by Pittsburg coal, of which it requires from thirty-five to fifty barrels per day. About 100 laborers are employed in the establishment. During the past winter, they worked thirty hogsheads of raw Sugar per day: and between the 1st of February and the 1st of August, 1832, they used 3,451 hogsheads of Sugar, the whole of which was of the Louisiana crop. No foreign sugars are used in the refinery; and it is asserted as the result of the experience of this establishment, that prime Louisiana sugars are equal in strength to any West India sugars, and that they yield as large a product.

### *Canby and Lovering, Church Alley, Philadelphia.*

We were permitted to examine this important and excellent establishment, with all necessary deliberation. It is well worthy of a distinct notice; but that which we shall now give will be the more brief, because, in the preceding pages, we have already described, under another head, the most important details of this method of working.

### *Animal Carbon.*

Animal carbon being here exclusively used for clarification, blood, clay, and lime, are entirely excluded, except a little lime water, to remove acid from molasses. Animal carbon is now prepared largely in all our cities, where its use is required. The process is, by heating bones for about twelve hours in close vessels. In Philadelphia it is prepared by Cornelius Tiers.

In the refining of Sugar, it is used in the proportion of from three to ten per centum, according to the quality of the Sugar. The average of Canby and Lovering, is about seven per cent. They do not use the finings of Mr. Howard, nor any other finings, nor are they used, as far as we can learn, any where in this country, except at New Orleans.

### *Liquoring.*

Instead of claying, they resort to liquoring;—that is, to the filtration of syrup, through the loaves or lumps of sugar. The liquor is made from sugars of different qualities—always better, however, than the Sugar which is to be whitened; and when loaves of the first quality are to be made, the liquor is prepared from the finest materials.

### *Manner of applying the Liquor.*

The liquor, being a substitute for the wet clay, is poured, from tin

watering pots, into the reversed moulds or cones, and it removes the molasses, by washing it out, exactly as the clay water would do; but, being a strong solution of Sugar, it cannot, materially, diminish the quantity in the loaf, and, as happens in the case of claying, the whole of the saccharine matter must be found, either in the loaf, or in the syrup. The liquor, while it will not impart any color, will probably be more effectual in removing it, than water flowing from clay, as the Sugar, in solution, will attract the coloring matter with more energy than mere water would do.

Clays are, not unfrequently, tinged by metallic or organic matter, and then they impart color, instead of removing it; but such clays are generally rejected by refiners.

In the mode of applying the liquor, this house have some admirable arrangements, which, being confidentially exhibited and explained, we are not at liberty to speak of, except in very general terms. We may say, that the process is only an application of a principle of science to a practical act, and the observer sees, at once, a fine philosophical experiment, and a grand economical result.

The importance of this result is apparent from the fact, that not only common Muscovado sugar, but the crude dark sugar, (obtained from molasses,) is, by this particular mode of liquoring, converted into very beautiful coffee sugar, and that with great rapidity.

In the manner alluded above, it is, hitherto, practised no where except in Philadelphia and in New Orleans. The drainings are again converted into Sugar, or retained in the form of molasses. The liquoring is usually repeated twice, or sometimes even thrice, on the same Sugar.

### *Filtering.*

The filters are made of a close strong bed ticking, of cotton, and are stretched on a square moveable frame, as long as half a common window. The frames are placed vertically, and the liquor passes through them, by hydrostatic pressure. One filtering answers the purpose. The filtering cloths become very foul, and are cleaned, once a day, or at every operation; it is done, by rubbing them with a brush and warm water. This invention is patented, and is, of course, public.

### *Evaporation.*

This is conducted upon the principle of Howard, that is, in a vacuum.

We are not at liberty to state the details of the excellent apparatus, in the refinery of Canby and Lovering. It is of easy management, effectual, rapid and safe. The evaporation proceeds, at about 150° of F., a temparature, nearly 100° lower than in the old evaporating pans. At this low heat, the delicate arrangement of the elements of the Sugar, is not disturbed, and the syrup is, very rapidly, brought to the crystallizing point. In the process by the vacuum, there is no necessity for throwing butter upon the frothing fluid, to prevent it from boiling over. There is a cavity into which this frothy effervescence passes, and, also, an apparatus fitted to receive and preserve that part which does not fall back into the boiler.

The temperature is observed by a thermometer, and the pressure by a barometer. The temperature, as already stated, is generally about 150°, and the pressure about two and a half to three inches, upon the surface of the liquid in the evaporating pan. Although a charge of 200 gallons is worked off in twelve or fifteen minutes, still the low temperature, stated above, is maintained in consequence of the rapid removal of the vapor, by the steam engine and air pump. In the vacuum apparatus, of every variety, there is no need of a safety valve, as the pressure is not outward but inward, and as all of these vessels have a convex form, the external atmospheric pressure is thus easily resisted. There is an orifice by which the atmosphere is let into the pan, when the contents are to be drawn off into the open granulator or crystallizer.

It is almost unnecessary to add, that the syrup is clarified and filtered before it passes into the evaporating pan.

### *Crystallization.*

This often takes place, in part, in the vacuum, before the charge passes into the open crystallizing pan, which, in the case now before us, contains 400 gallons.

It is placed parallel with an iron vessel of the same form (that of a bowl) and between the two, steam enters to melt the sugar, and, if necessary, still further to evaporate the water, and the charge is laded directly into the moulds, which, as in the old refineries, stand very near to the crystallizing vessel.

In this vessel, we observed a thermometer suspended, its ball being in the liquor, and indicating about 150°. We have observed the thermometer in use in only three refineries. In the same vessel which receives the charge from the vacuum pan, they evaporate and crystallize the molasses, previously concentrated in the vacuum, and obtain a large product of coarse and inferior sugar, which crystallizes while the evaporation is going on, because the water of crystallization is not sufficient to hold it any longer in solution.

This sugar is, by the particular process already alluded to, very greatly improved in quality and made superior to the best obtained in the common way.

### *Miscellaneous Facts.*

The steam engines used in this refinery, are of low pressure, and the fuel is anthracite.

The vats, or blow-ups, as they are called, containing the sugar, molasses, or syrups, intended to be purified, are heated by steam tubes passing through them. The molasses is sometimes, as we observed in this instance, exceedingly foul, being filled with sticks, dirt, and other foreign matters, from all of which it is freed by the filters and the charcoal. The Muscovado sugars are also frequently very impure, and they are dissolved in the same manner by steam. The molasses or sugar is, at once, heated and dissolved by the steam, and also diluted to such a degree by allowing the steam to pass directly into it, that it will readily pass through the filters. There is here a very effectual float strainer, which is a hollow copper cylinder, or two cones, joined at their bases,

the copper being perforated by many holes; it is fixed on the end of a moveable copper tube, standing like a bowsprit, and that it may be made to float just under the scum, so as not to be choked by it, and still not be liable to sink too deep—there is fixed to the tube a hollow copper ball or balloon, made air tight, which sustains the tube at the proper elevation. In Howard's apparatus, the state of the syrup, in the vacuum pan, is ascertained by thrusting in, through an orifice prepared for this purpose, a sort of key called a proof stick; it is of a cylindrical form, and made slightly tapering; there is, on the side near the end which enters the vacuum pan, a small cavity, which, when the instrument enters, becomes filled with the syrup and retains it when it is drawn out. In the apparatus of C. & L. this object is attained in a manner more simple still, and equally effectual. This syrup should rope between the thumb and finger, or, when drawn along the ball of the thumb, just as is observed in the old process of evaporation in the open pan. If the evaporation be carried too far, the crystals, as already stated, begin to be deposited in the vacuum pan, from which they are, however, easily removed, either by the flow of the syrup, when it is drawn off, or by the introduction of a fresh portion of syrup.

Thomas Hewit has recently established a refiney in Philadelphia upon the plan of Canby & Lowering.

*Steam Congress Company—Archibald & Delafield, New York.*

There is little to remark respecting this establishment, which has not been anticipated. It enjoys the advantages of the vacuum, and the principles upon which it is conducted, are similar to those already described.

It is worked by a steam engine of eight horse power, and while it relies chiefly upon the improved methods, it retains, for coarser sugars, a limited use of clay and of blood.

Mr. Archibald courteously permitted us to see the apparatus, but the opportunity admitted of only a partial view of the operations. We believe, however, that there was nothing which requires additional details beyond those that have been already given. For a single day's work, the day in which we were there, the following were the times and the temperatures:

| *Times.* | *Temperature.* |
|---|---|
| Minutes 30 | 100° |
| 23 | 158° |
| 30 | 166° |
| 28 | 167° |
| 26 | 162° |
| 40 | 160° |
| 25 | 167° |
| 30 | 176° |

The atmospheric pressure on the surface of the liquid was from two to three inches of mercury.

We understand (May 27th, 1833) that this establishment has suspended its operation. There are, therefore, now, only three in operation in the United States.

*Opinion respecting the Steam and Vacuum Process.*

An eminent sugar refiner in London, gave it as his opinion, that the per centage of refined sugar produced upon Mr. Howard's plan, is not so great as upon the old system, and that its principal advantage is, that of producing sugar of a much superior quality, from raw sugar of the same kind. It has also the additional advantage of affording a larger quantity of bastard sugar, and consequently less molasses, while both of these are of a superior quality, and, consequently, all the products are better, although differently proportioned, as appears from the following table:

| OLD SYSTEM. From 1 *cwt.* (112 *lbs.*) *raw sugar.* | | NEW SYSTEM. From 1 *cwt.* (112 *lbs.*) *raw sugar.* | |
|---|---|---|---|
| Refined | 68 | Refined | 64 |
| Bastards | 19 | Bastards | 29 |
| Molasses | 21 | Molasses | 15 |
| Waste | 4 | Waste | 4 |
| | 112 lbs. | | 112 lbs. |

## 2. THE OLD OR GERMAN METHOD, BY BLOOD, EGGS, CLAY, &c.

This method of refining has been frequently alluded to or mentioned, in the preceding account. A more detailed statement seems, however, for the following reasons, to be necessary on the present occasion:—

1st. Because this method is still generally followed in this country, and it is, therefore, desirable to understand it, as actually practised at this time.

2d. Because we cannot justly appreciate the advantages of the improved processes, without fully understanding the old.

3d. We shall thus, by comparing the manufacture, as now carried on here, with the full accounts of it which are given by various authors,* be enabled to understand, how little its processes have changed in a long course of years.

The information now to be presented, was obtained by a careful examination of some of the largest and best conducted establishments, in the principal cities of the United States, aided by the most unreserved and liberal communications on the part of the proprietors and conductors, and we will pursue the actual order of the investigation, because the facts will then be presented to the reader, exactly as they were seen by the observer.

1. We will describe with all necessary details, a principal refinery of the old class.

2. We will add notices, more or less extended, of several others, in different cities.

3. We will add a summary of the most important conclusions.

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* Art. Sugar, Rees Cyclopædia. Art. Du Raffineur, &c. par M. Chandelet, Paris, 1828. Manuel du Fabricant and du Raffineur, de Sucre, Paris. Report to the Minister of Commerce and Manufactures of the French Government, &c.

## NEW YORK.

### 1. *Refinery of Teaman, Tobias & Co.*

This is an old and wealthy concern, which, with some change of copartners, has been in operation between forty and fifty years. The manufactory is carried on in Liberty street, in the same building, which was known, during the revolutionary war, as "The old Sugar House," and which, while the British held possession of the city, was used as a prison for captive Americans, many of whose names are still legible, rudely cut in the solid walls.

We commence with this establishment, as through the politeness of Mr. Tobias, one of the copartners and the immediate superintendent, we had an opportunity of a minute inspection of the works and processes.

There are two circular copper boilers, called pans, placed in a line with each other, on one side of the room; separated by a brick wall, through which the flues of the furnace pass. To aid in heating the pans, there is also, on the other side of each pan, a wall similarly covered, through each of which runs a flue, to prevent the syrup from soaking into the brick work. These walls, covered with sheet lead, are about two or three feet higher than the tops of the pans, and about 12 or fifteen inches wide at the top, gradually widening to their base. The pans are five and a half feet high. They are set in brick work; and for the convenience of passing the sugar and other materials, into and out of them, they are supplied with what is called a brace—that is, a part of the front of the pans, for about two feet downwards from the top, and including from two-fifths to one-third of the pan in the line of its periphery, is made to ship and unship. When the pans are being charged, these braces are removed, until the pans are filled, as far as they will allow without the braces; when these are returned to the pans, and are kept in their places by flat copper (in some manufactories iron,) clasps, opening downwards, and rivetted to the braces; thus securing them to the body of the pan. A thick piece of wet linen or hempen cloth, (sometimes in various thicknesses of the same,) is first placed around the edge of the pans, where the brace is to be shut on, and this secures them against leaking. Underneath each pan, is a furnace for burning bituminous coal.

The first process is, to conduct into the copper pans, through a pipe, from a wooden cistern outside the building, a quantity of lime water, which is kept in constant readiness in the cistern for that purpose. This cistern is capable of holding about sixty hogsheads of water, supplied in ordinary times from the roof of the building. The lime used, is in the ratio of one barrel of lime to sixty hogsheads of the water. The amount of the lime water to be passed, in the first instance, into the pans, will be proportioned in reference to the comparative foulness of the material to be refined. If it is white Havana sugar, the proportion will be 175 gallons to 3,000 pounds of the sugar, or about one gallon of the lime water to seventeen pounds of the sugar. If Muscovado, then a gallon, to about fourteen or fifteen pounds of the sugar,—always having regard to the quality of the Sugar.

The lime water, having been supplied to the degree, which, in this instance, was thought necessary, the article used being a Muscovado of

middling quality, six hogsheads of the Sugar containing, in the aggregate, in net weight, about 5,500 pounds, were put into the pans, distributing the same about equally between them; which, with the lime water, was near the amount. they would contain. While they were being charged with the Sugar, 3½ gallons of fresh bullock's blood were put into each pan—and no other albumen is, ordinarily, used in this establishment—they make no use of charcoal—sometimes, but very rarely, however, the white of eggs, are employed, for double refined loaves, if they wish to be very particular. In the course of this clarifying, about three gallons more of the blood, were distributed between the two pans.

The amount of this article, as well as of lime water, admitting of no previous and precise rule, any further than to use no more of either, than is necessary, both or either, are added, from time to time, during the clarifying, as the state of the liquor shall indicate.

The office of the lime water being, as the superintendent expressed it, to neutralize whatever of acid* the Sugar may contain; and thus extricating the impurites in the body of the sugars, to place them in a state to permit the blood in its diffusion through the mass, to entangle them and carry them, with it, to the surface, where they are passed off by the skimmers. The refiner is less cautious in the use of the blood, than in that of the lime water—for while the former will find its way to the surface; if there be an access of the latter, it may, according to Edwards, communicate a bitter taste to the Sugar, and according to the experience of this establishment, it may create a grey hue, which will be perceived when the drainings and clayings have terminated—in which case the Sugar will have to be pounded or ground up, and again subjected to the clarifier, and mixed with other sugars.

When the pans have been filled, or charged, as it is termed, a fire is moderately applied to them. After stirring the mass a little at first, the heat is, gradually, increased, until it arrives *near*, but not *up to*, boiling heat. The reason of which is, that while it remains short of boiling, an unbroken scum will make its appearance, at the top, gradually becoming thicker and thicker, but which, if allowed to boil, bubbles and breaks. The surface thus disturbed, the earthy particles, and other impurities, will be again precipitated into the body of the liqor. In from two to three hours, perhaps three and a half, according to the cleanness of the Sugar, the whole of these impurities will have been brought to the surface, unless (as in the case of sand, &c.) they are too gross to be controlled by the albumen. This scum, in its last stage, varies in thickness, from four to six, and even ten inches, according to the foulness of the Sugar; and is now removed by the skimmer, which is of copper, in shape resembling a common ditching spade, but, like that, wider and rounder at the corners, and affixed to a wooden handle, of six or eight feet in length, perforated like a skimmer.

The panman continues to skim, until the liquor sends up a white, milky looking froth, which is an indication, that the clarifier has performed its office; except the sand and other ponderous crudities, which the albumen

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*This has been the current opinion, but there is reason to doubt its correctness; if acid were present, it would, indeed, be neutralized by the lime, but it is probable that its principal office is to coagulate the feculencies

could not bring up. In this case, the process of clarifying occupied about three and a half hours. Here the panman further tests the purity of the liquor, by taking out a small amount of the same, with a metal spoon. If the liquor be not transparent, but there is still a degree of turbidness remaining, he applies a little more blood, and perhaps lime water, also, at his discretion; and continues the heat until the liquor will sustain the test. But at this stage, a little longer continuance of the heat will, frequently, effect his purpose. The scum is, in the mean time, passed off into a portable tub, or other convenient vessel, and deposited in a cistern to abide a future disposition.

The clarifying having been brought to the abovenamed point, a wooden trough of sufficient length to reach from the farther side of the remotest pan, across its fellow, to the middle of the cistern, is so placed as to convey into the latter, the contents of the former. The cistern itself is an oblong vessel, made of copper, adjoining one of the pans. This one was five feet eight inches in depth—six feet three inches in length—three feet six inches in width, and capable of holding the contents of both the boilers or pans. It is open at the top, and just within it, supported by bars of wood or iron, across the cistern, stands an oblong basket, into which is put a woollen blanket, whose edges are thrown over the sides of the basket. Upon this blanket, as it comes from the pans, the liquor is poured, which is called *"skipping it off."*

For this purpose, one man takes his position at each pan, with a large copper dipper, affixed to a long wooden handle; and dipping the liquor from the pans into the trough, it runs along through it, into the basket, and percolating through the blanket, is received into the cistern. When they have, in this manner, reduced the liquor in the pans to the level of the braces, they take them off the pans, and they are not replaced until they are again filled with the liquor, on its return from the cistern.

The blanket, after every second charging of the pans, with Sugar, viz: after every two days' work, is taken from the basket, and its contents, consisting of sand, sometimes, of old nails, and other insoluble substances, are thrown out, when the blanket is washed in the clarifying pans, and replaced in the basket; the washings of the blanket, like all other washings, which suspend any portion of saccharine matter, being laid aside to be clarified over again.

Immediately after the clarifying pans have been discharged of the liquor, they are washed clean. This done, the liquor is returned to the pans, *now to perform the office of evaporation.* But, before we describe that process, we will dispose of the same; for the profits of the refinery depend, in no small degree, upon the minor points of economy; in husbanding every thing, in which any portion of the saccharine matter remains.

Into two coolers, (which, in this manufactory, and, I believe, in all others which refine upon this plan, are *circular copper basins;* in this case, they are four feet eight inches in diameter, and one foot seven inches in depth,) oblong baskets are placed, one in each cooler; into which are put thick hempen bags—one bag to each basket—and which, being filled with the scum, the mouths of the bags are twisted tight, by means of cords and sticks, which operate as levers to tighten the cords. Upon each bag is placed a circular board, or thick perforated plank, considerably less than the diameter of the *coolers,* (which, though not their primary and most im-

portant use, are made to answer also as recipients for the liquor to be expressed from the scum). Heavy weights are then piled on, in such a manner as to equalize the pressure, until they amount to the requisite load for expressing the same. This must be attended to, as soon as possible after the clarified liquor has been delivered into the cistern. In the course of an hour or two, and so on, occasionally afterwards, the weights are taken off, and the necks of the bags twisted round again, and the boards and weights replaced. The liquor suspended in the scum, continues to exude for about twenty-four hours, and is, generally, clear enough to be incorporated with the other liquor in the *evaporating* boiler. The residuum of the scum, still retaining a small portion of the liquor, is sold, usually, to some cordial manufacturer, who extracts whatever may be farther obtained from it, and mixes it with other saccharine materials.

We now return to the evaporation of the liquor, which we left in the cistern. In this cistern is a copper pump and *in* the trough, by which the liquor was passed into the cistern, and directly over each pan, is a hole, stopped by a plug. By means of this pump, and trough, and by opening the plugs, the liquor is returned to the pans; at first, only one-sixth of the liquor, which is, equally, distributed between the pans. The foreman determines the quantity by applying his guaging rod to the cistern. A brisk fire is now applied to each boiler. In a very few minutes, the liquor begins to boil. In from twelve to thirty minutes, according to the strength and richness of the liquor, "the evaporation will have produced its effect, and the liquor will acquire the requisite degree of viscousness." In boiling, the liquor will, frequently, rise to near the top of the pan, in this case, the panman prevents its boiling over, by throwing upon it a little butter, which, always, stands by the boilers, for that purpose. As the evaporation draws to the point, which is wished for, the man at the pans, frequently stirs the liquor, with his wooden oar, occasionally suspending a portion of it with the oar, and making his observations upon the progress of the evaporation. As it nearly approaches the desired point, the foreman runs the ball of his thumb along the liquor, as it is taken up upon the blade of the oar, and gathering up a portion of it, (and turning aside to a box of sheet copper, resembling a candle box standing upon one end, with the cover, that is one side, off, the open side being next to him, and blackened in the inside, and in which a lamp or candle is placed,) brings his forefinger to his thumb, and then withdraws it—at the same time bringing the liquor in a line between his eye and the light in the box. If the evaporation be sufficiently advanced, the liquor will be ropy, and draw out a thread, the consistency of which will indicate whether the time has arrived for discontinuing the process. This is a pretty nice point, and a correct conclusion must depend upon a practised eye. If too much evaporated, it will drain but imperfectly, and must go back again into the clarifier, and be worked over again with other Sugar; and if too little, it will drain too much and yield but little Sugar. The moment it is found that the evaporation has been carried to a sufficient extent, the boiling must be discontinued. The doors of the furnace are now thrown open—fresh fine coal is cast upon the fires to dampen the flame,—and water upon that, but not to extinguish it entirely.

Previous to this, the liquor obtained from the scum, has been removed from the coolers, and on the top of each cooler, a brace is placed, of

about half the periphery, and about two feet or two and an half feet high. This is on the side next to the boilers, and opposite to which boilers, the coolers are situated. The difference between this brace and that upon the boilers is, that in the latter, a part of the side of the boiler is *taken off,* and leaves an unequal elevation—whereas, in the former, the same unequal elevation is produced *by adding* the brace. In the sides of the braces to the coolers are doors, which are opened while the liquor is being unladen from the boilers.

As soon as possible, after damping the fires, (for the operation requires much alacrity,) two men commence with their copper tube or buckets, which are filled as before described by the copper ladles; they are dipped full by a third person who stands ready for the purpose, and the liquor in equal proportions, is transferred from the boilers, through the doors of the braces, into the coolers. On the other side of each cooler stands a man with a wooden oar, about seven or eight feet long, and, to prevent the surface from crusting, he moderately stirs the liquor as it passes into the coolers. When the boilers are discharged, or *nearly so,* (for, in the first boiling, they are not very particular to take out the *whole,*) the doors of the braces are shut—when the men, with the oars, commence a vigorous agitation of the liquor, alternately, pushing the oars from, and then drawing them towards themselves; thus producing a constant current of the liquor from them, and a counter eddy current towards them. The use of the brace, it will now be perceived, is, that by giving additional height to that part of the cooling pans, opposite to where the men stand, and towards which they push, the liquor is thus prevented from dashing over the sides. In a few minutes, the viscousness of the sugar ceases, and the granulation (crystallization,) is produced, and the men desist from working their oars.

In the mean time, another one-sixth part of the liquor in the clarifying cistern is pumped off into the boilers, and distributed between them, as before—the same process of evaporation is repeated, but during this second process, a portion of the liquor, which had been derived from second and third drainings of lump-sugar, already refined, was conducted into the boilers, through pipes from the draining lofts above, (in this instance about forty-five gallons,) and incorporated with the other liquor. The second evaporation being completed, the contents of the boilers are, without delay, passed off into the two coolers, directly upon the top of the Sugar already granulated; when, without waiting for a similar operation with the oars, except in a very slight degree, commences the lading of the contents of the coolers into the moulds—the granulation effected in the mass first passed into the coolers, being sufficient to complete the granulation of both the boilings. To insure this effect, the boiling and granulation of the first portion of syrup were permitted to proceed further than they, otherwise, would have been suffered to go, had not the second boiling been intended to be, ultimately, incorporated with the first. After this second boiling, the superintendent was careful to have the whole of the liquors emptied from the boilers, as they were now to be cleared out anew, in pursuance of his rule to thoroughly clean the pans upon the completion of the evaporation of every one-third part of the liquor. After this, the remainder of the liquor in the cistern was worked off, proceeding in the same manner, including a correspondent amount of the second and third drainings from above. It

will be remarked, that the liquor derived from the scum, was also mixed up with the other from the cistern, during the evaporation.

We now proceed to the filling of the moulds, from the sugar in the coolers. The moulds, as is well known, are of a conical shape, and made of red earthen ware, unglazed; and are of various sizes, according to the description of sugar, which is to be placed in them. They, as well as the pots, for the drainings, were formerly all imported, but are now furnished to this establishment, from Norwalk, in Connecticut; and the clay used in the refinery is from Long Island.

At the lower end of the mould is a small aperture, intended for the sugar drainings to escape through. The moulds are washed clean, and if previously used, are also soaked, for the purpose of divesting them of all the sugar and clay and drippings of syrup, which may have adhered to them. The aperture at the end, is stopped by twisting through it a piece of stiff paper, such as is used for outside wrappers of the loaves. The moulds are then set, inverted, on the small end, in rows, at a small distance from the coolers, and at first four deep, balanced against each other, and by other moulds, which are placed upon their base or large end. One end and the whole of the first tier lengthwise, are set against the sides of the room—the rest balanced in the manner named—the balancing moulds being generally those which have been broken and are fit for no other use. They are at first only four deep, as it is not convenient for those who fill them, to reach over more of them at a time. Two men, with each of them a large copper bucket, bail the sugar from the coolers into the moulds. They fill them at first but partially, say two-thirds or three-fourths, leaving space in each mould for its due proportion of that part of the sugar at the bottom of the coolers, which was first put in, and was most granulated. The filling of the first lot of moulds is finished, so as not to interfere with having the coolers ready for receiving the next liquor from the boilers; which have now become charged anew for another evaporating process. Other moulds are placed in readiness, arranged as before along side of those already filled, and in sufficient numbers to keep up with the work. When the cistern has been completely worked off, and the contents evaporated, and granulated, and placed in the moulds, the latter are permitted to remain stationary until the sugar has obtained sufficient consistency to bear removing, which will be either the same evening or the next morning; the filling of the moulds having usually been completed about noon. The remaining part of the day's work in the clarifying room, is to clean and recharge the pans with sugar for the ensuing day—cleaning up the works generally—and scraping up the liquor and sugar which may have been spilt or scattered in the course of the day. This is true if the sugar is good, but if very foul, it will take more time, and the work will not be through until 3 or 4 P. M.

It will be borne in mind, that the process now going on, was that of refining the Muscovado into lump—the difference between which and the other kinds of refined sugar, so far as they are ordinarily manufactured in our country, will be pointed out in their proper place.

When the moulds have been hoisted into the draining room aloft, which is usually done in tubs or buckets, the paper stoppers at the ends are taken out, and each mould is set upon an earthen jar or pot, whose mouth is just sufficient to receive enough of the small end of the mould,

to enable it to stand upright. In this situation they remain for about twenty-four hours, if lump or loaf, by which time they will, most probably, have become sufficiently solid, the syrup or more fluid parts having retired to the bottom or small end of the mould. If not, the moulds are permitted to remain until they have become solid, which may be one or two days. They, viz: the moulds and their contents, are then taken off, and the drainings in the pots are emptied into other and larger pots, and put aside to be incorporated into the manufacture of bastard sugar, which will be hereafter described.

The moulds are now replaced upon the pots, and a wet and finely worked clay is poured upon the top or broad end of the mould, entirely covering the sugar at that end. The clay when dry, is from half an inch to an inch in thickness. If, as generally happens, the surface of the sugar, in consequence of the first draining, should present at the top or broad end, an uneven surface, hollowing down in the middle, it must, before claying, be pressed down and rendered smooth, which, in its then tender state, can usually be done with the hand. The moulds are now permitted to stand about five days and longer, if the weather be damp. The pots are then emptied a second time, the moulds replaced and clayed anew; and permitted to stand upon the pots about eight days, when the draining is again poured off. The lump is once more clayed and the mould replaced upon the pot.

It is proper here to remark, that the 2d and 3d drainings are placed together and reserved to be put into the clarifier for the next making of lump; but the first draining of the lump is always reserved for making the bastard sugar.

On removing the 1st and 2d clays, the broad end of the lump will again exhibit inequalities upon the surface, which must be filled up partly by chipping off the protuberances and partly (mostly) by filling in with other sugar of the same kind, ground down and powdered, and which is patted and smoothed down by a trowel. The sugar principally used for filling in, is either broken lumps or the tips or small ends of lumps, which have been severed from the main luup bfore it went into the oven.

The lumps are permitted to remain under the 3d clay about five days, when the pots are emptied and the mould is replaced. In about three days more, the lump is dry enough to be taken off the clay; and in four days after that, to be taken out and put into the oven. Generally, however, there will remain, at the small end of the lump, a portion of the syrup and moisture; enough to give some discoloration, and which, indicating an unfinished state, would, if permitted to remain, injure the sale, which, by further efforts, might however be removed; but the refiner instead of continuing those efforts, most frequently cuts off as far as the discoloring is perceived, which may be from three to five inches; and which goes, as already alluded to, to the filling up of other lumps, or into the clarifier, for the reproduction of sugar of the same quality. Sometimes, however, though not often, the whole lump is perfect after the third claying; a fourth claying is sometimes resorted to.

We have omitted to mention, that for the last few days the lump, if permitted to remain in the mould, previous to its being put into the oven, should occasionally be shaken or knocked against a post or some other fixture, to render it loose and keep it from adhering to the mould.

We will now refer to the oven. A furnace is placed in the lower story of the building and heated with bituminous coal. The heat first enters through an inverted cast iron funnel, and is conveyed, by means of a pipe, into the oven, which is placed in an upper loft, say the finishing room, and passes from the lower story through two or three stories to form one great cavity, in the bottom of which is the furnace. The dimensions of the oven, in this establishment, are in height about twenty or twenty-five feet, in length about fifteen feet, and in width about twelve feet. On the sides of this apartment are racks or shelves, upon which the sugar is deposited. The heat of the oven, is kept at a temperature of about 130° Fahrenheit. The loaves are papered before being put into the oven; the lumps are, generally, but not always, papered, and sometimes go in naked. The lumps are allowed to stand in the oven until entirely dry, which will be in about five or six days, according to their state when put in, and the degree of heat which is kept up in the oven. In damp or cool weather, all the upper rooms where the sugars are draining, are also heated with stoves.

When *loaf* sugar is made, or the *lump* is so perfect as not to have the top broken off, there will still remain a certain amount of moisture at the small end. It is an object to have this diffused through the *loaf* or *lump* to such a degree that it shall not be perceptible to the eye, or occasion any injury from its dissolving agency, remaining local. For this purpose, before being placed in the oven, the *loaves* or *lumps* are inverted and put, while still in the moulds, upon the base or broad end of the mould, on a platform of brick (covered with clean paper) forming the top of the oven outside, and where there is a little (and but little) heat; and where they remain for a short time until the object is effected. The moulds are kept on; for should they be left uncovered, and subjected to the influence of cold air, as by the drafts of windows or otherwise, we have the authority of Rees' Encyclopædia, that "the moisture remaining in the head will not descend into the body of the loaf; but remaining in the head, would spoil and disfigure the loaf, partly by the syrup's coagulating and becoming unfit to descend between the fine interstices of the concrete body, and partly from the more perfect concretion of the solid particles." When the sugar comes out of the oven, it is fit for market. But if the *lumps* are intended for export, (in which case they are entitled to the benefit of drawback) they are broken up and powdered, which is commonly done by a mill constructed for that purpose, and which, in the present manufactory, is a small machine worked by hand; and the sugar, when thus ground, is called crushed sugar.

The next description which will claim our attention, is what is called the bastard sugar. This is made from the first drainings, as above, of the *lump;* or of those compounded with a portion of inferior Muscovadoes; and such scrapings of the sugar-house as can be collected. The bastard sugar must remain a week, sometimes eight or ten days, in the mould, before it is begun to be clayed; and in order to have it sufficiently concrete to begin the claying, the stopper at the end is taken out; and a stick of some size is run up several inches into the small end, to break through the crust, so as to enable the sugar to drain. If there are lumps or loaves, an awl is run up to relieve the liquor. The lime water and blood will be in proportion to the foulness of the materials.

The future stages of the manufacture will be the same as already pointed out, except as will be noted in the sequel. The loaves of this sugar, and consequently the moulds, will be much larger. The bastard undergoes only two clayings and drainings. The latter called molasses, (and which molasses is not, in this establishment, refined again,) and sold as such, but superior to the imported molasses. It is emptied into a vat, through the floor of the draining room, from which it is drawn off into hogsheads. The bastard is the most common kind of brown sugar known in our manufactories. When made, it is ground up and intended for the home market.

We have dwelt more particularly upon the *lump* and bastard, as those are the two kinds in which this refinery is at this moment employed; and the different stages of which we have had an opportunity of witnessing. This house is also occasionally occupied largely in the refining of the other kinds of sugar, and we have been favored with such communications as have rendered the process of the single and double refined fully intelligible.

The single loaf is *once*, the *double loaf* twice, refined. The leading processes, mutatis mutandis, as heretofore remarked, are the same as in the manufacture of the *lump*; differing principally in the degree to which the refining is carried.

Although the *loaves, single and double*, as well as the *lump*, may always be manufactured from *Muscovado*, it is for the interest of the refiner, in the ordinary and comparative prices of the crude material in the market, to start with a material proportioned to the nature of the article which he intends to produce. Thus, if *loaf* be that article, Havanna or Brazil whites. If lump, then Havana browns or Muscovado; and of the Muscovadoes, Porto Rico or St. Croix. We speak of the two latter as being in the market, though many more inferior kinds of Muscovadoes are made use of, and there are some, we believe, of the high gradations of Muscovadoes from the British West India Islands, which are not often in our market. The Manilla clayed sugars, although some of them are very brown, are used; as they are strong in saccharine matter. The Havana browns make the best *lump;* for the bastard, the materials already named are those commonly used.

In a word, in the ordinary state of the market, as respects the article to be refined, the better the sugar when it comes into the hands of the refiner, the more for his advantage, provided the price be not too high, as it leaves him less to do. This remark is confined, of course, to the best kinds of refined sugar—for the remainder are based upon the inferiority of the article to be refined.

For the manufacture of the *double loaf;* the *single* loaf, and sometimes the *lump*, is ground down, and again subjected to the clarifying process. For this article, the refiner occasionally purchases the *single* loaf, already manufactured, when he happens to be able to avail himself of it, at a lower rate than he himself can manufacture it.

In producing the *loaf*, more nicety is required, in the claying and trimming it off—in stirring the sugar in its first stage in the mould, in order to lay the parts of the sugar even in the mould—more also in the *subsequent* clayings, to prevent the loaf from adhering to the moulds—and where it has done so, to scrape the sugar from the mould, and see that the face of the loaf is kept cleau and smooth. The fillings

up of the *loaves* will always be of the quality which the refiner is producing at that time. If in the course of the last claying, any loaf exhibits a tardiness in draining, and consequent want of whiteness, another claying is sometimes applied, and the refiner also sometimes clears off, by dissolving sugar of the same quality, with a little clear water, and pouring on small quantities at a time. The loaves are permitted to stand longer in the moulds, and sometimes more heat is applied to the room. "The fine double loaves," says Rees, "may "be kept in a room of the temperature of a common parlor—a little "warmth is sufficient for fine single loaves—inferior loaves and lumps "and bastards thrive in a glowing heat. Every sort of refined sugar "will bear and require more heat in proportion as it is higher boil- "ed—for the brown syrup will not quit the denser, unless it be kept "in a fluid state—and this can be effected only by the action of heat— "and, moreover, the fluid parts of high boiled goods must be more "viscous than those goods which have been less bound up by fire." The views taken in the above quotation, correspond perfectly with the experience of the refineries in the city of New York.

It is evident, that the purer the sugar, when placed in the clarifier, the less lime water or blood, or temper of any kind—the less *time* in clarifying—and the more activity vigilance at the clarifier—and the more activity also in transferring the liquor from the evaporator into the cooler will be requisite. By too great heat, the sugar may be burned; and if not *burned*, it may, as already pointed out, be prevented from *draining*—two hazards which inexperience or carelessness will be particularly apt to bring to sugar of a higher kind—and by being permitted to remain too long in the pan, it will be too coarsely granulated.

In the manufacture of the double loaf (in the establishment whose operations we are particularly detailing) they are sometimes enabled to substitute *pure water* for the lime water; and, of course, with materials of such superior quality, very little blood is used. The white of eggs they grant to be better, but seldom make use of them as being too expensive. They sometimes have, as named by Rees, used indigo to heighten the color of the *double* refined loaf; but they seldom resort to it.

The greatest drainings, as might be supposed, are from the *bastard.* A mould, which when first filled from the cooler will contain 200 lbs. of the syrup will produce 60 lbs. of the *bastard*—the residue will be molasses. A mould containing 28 lbs. of liquor, as above, (the lump moulds, as already observed, frequently hold 200 lbs of the liquor) will give 10 or 12 lbs. of *lump*—one of 12 lbs. will give 6 lbs. of *single loaf*—and one of 12 lbs. will give 6 to 7 lbs. of *double loaf.* In producing the bastard, less care is taken in the ulterior stages of the refining, than with any other kind of sugar. The are not particular to perfect the small end of the bastard. They cut it off, and after breaking it up, it goes again into the clarifier, and is worked up with the usual materials for the same article.

Suppose that this establishment were manufacturing all the three lower descriptions of sugar, to which we have had reference; the order would be as follows, viz:

| | | |
|---|---|---|
| Two days loaf, | | And the last day, say one day more, would |
| Nine " lump, | } | be spent in washing, cleaning pans, and collect- |
| Three " bastard, | | ing refuse sugar and syrup, &c. for bastard. |

Should they, which is very seldom the case, refine the double loaf at the same time, it will precede the single loaf by one or two days. It will be perceived, that one reason for this interval or succession of different kinds of sugar, particularly lump, is to accumulate drainings for the next lower kind.

The amount refined annually in this establishment, if confined to Muscovado, would be about 1200 hogsheads, at 1250 lbs. each, 12 lbs. off tare=1,487,500 lbs. call it 1,500,000 lbs.

If confined to Havana white, 3,200 boxes, of 475 lbs. each, 15 lbs. off tare=1,512,000 lbs. call it 1,500,000 lbs.

*Refinery of Meday & Ritter—Pans, Boilers, Evaporators.*

In another respectable establishment in New York, the boilers, which are also evaporators, contain, when the brace or moveable front piece is on, 5,000 pounds of common raw sugar, and 6,000 pounds if the sugar is of a very good quality.

The coolers are low cylindrical coppers, placed ten or twelve feet from the boilers, on the opposite side of the room. Into these, the evaporated syrup is transferred, by means of large copper buckets, having iron handles on their sides; their form is not unlike that of a common coal kettle, and they are filled by large copper ladles, fixed to long poles, which enable the workmen to dip up the syrup, without suffering inconvenience from the heat and the vapor.

*Scum-Cisterns.*

The scum-cisterns, as they are called, are cubical boxes of wood, destined to receive the floating coagulum, formed by the heated blood and the various things with which it is mixed or combined.

The scum is placed in a hempen bag, whose neck is twisted by a rope connected with a stick, and pressure is applied between circular perforated planks, the upper one being loaded with weights. The saccharine fluid which exudes, is of a dark color, but is not particularly disagreeable, and is reserved for future use.

*Lime Water Cistern.*

The reservoir of lime water is a cistern of wood, containing probably one hundred and fifty barrels. It passes through the floor, and opens into the story or flat above, while its base is higher than the boilers, which are placed in the lowest apartment, in the cellar, so that the lime water flows into them, by turning the key of a stop cock placed at the end of a tube.

They use, in this refinery, about twenty barrels of lime a year; the best is considered to be the cheapest, and that from Providence, Rhode Island, is preferred.

This lime water cistern, as is generally the fact in the sugar houses, is open to the air; its entire upper surface being exposed. It happens,

of course, that a crust of carbonate lime is constantly forming, like ice, upon the surface of the water; this breaks and falls to the bottom, and is succeeded by another, and thus, in time, the whole of the lime that was in solution, would be precipitated, in a mild and inactive state, incapable of being redissolved.

For this reason, in philosophical laboratories, lime water is kept in close vessels, that it may not come into contact with the carbonic acid gas, which is always present in the atmosphere, and invariably precipitates the lime from lime water, which is in contact with it. In large establishments it might not be easy to prevent this effect; and still it might be worth while to fit on an air tight cover, furnished with proper orifices, for the introduction of fresh materials, and to admit the atmospheric pressure, when the fluid is to be drawn off. As the business is now managed, there must be a serious waste of lime, and the lime water may become weak and inefficient, before the manufacturer is aware of it. This is the more likely to happen, because the precipitated carbonate of lime may be abundant upon the bottom of the cistern, and give rise to the erroneous impression that there is a great supply of caustic or quicklime, while, in reality, it has all passed to the mild or insoluble condition, and has become a substance similar to chalk, limestone or marble. The manufacturers with whom we conversed, did not appear to be generally aware of these circumstances, and it is probable that they rely upon the characteristic taste of the lime water, which, as is well known, is decidedly alkaline; there may, however, be a considerable loss of strength in the lime water, while the peculiar taste is not destroyed. We are informed, that the general pratice in sugar houses is, to add fresh lime once a week, at the same time stirring up the materials, that the water may become all impregnated, and giving it time for clearing itself by subsidence, before it is again drawn off for use. In the upper part of the cistern this happens in a few hours, and it gradually extends through the whole.

### *Drying Stove or Oven.*

The drying stove or oven begins upon the lower floor and rises through four stories, from all of which it is accessible. Still, for the economy of heat and space, the stories in sugar refineries are generally low, and therefore the entire height of the oven, in the present instance, scarcely exceeded twenty-five feet, while it was fourteen or fifteen feet long, and nine or ten feet wide. Shelves, composed of narrow parallel strips of boards, placed at proper distances to receive the lumps of sugar, occupy the entire space, except a narrow alley in the middle, along which the men pass by stepping upon temporary cross pieces, laid in, when they are needed; or by reaching from side to side, with the feet, as in a well. An oven of the above dimensions will contain 4,000 lumps weighing from seven to ten pounds each, or from 28,000 to 40,000 pounds of sugar.

The temperature in the drying ovens often rises to 130° or more; if it is too high, the sugar is liable to be scorched.

In the building at large, the temperature of 80° is often maintained by stoves, which, by means of tubes and the circulation of the rarefied air, diffuse the heat every where. The degree of artificial heat applied, de-

pends, of course, upon the state of the weather, in regard to moisture and cold.

Bituminous coal is used in all the operations requiring fire.

### *Miscellaneous facts and remarks.*

Clay for the process of claying, is obtained from Cow Bay on Long Island; it greatly resembles that of Amboy, New Jersey, which is used in making coarse pottery. It is, in this refinery, mixed with water, in a cubical box on the ground floor; it is not ground, but falls to pieces, and, in the language of the workmen, it dissolves—that is to say—in a minute state of division, it is diffused through, and blended with the water, forming a pulp, which can be readily dipped up and poured out again.

For the manufactories at Boston, the clay is obtained from Gay Head in Martha's Vineyard; it is of the first quality, and is worth five dollars a ton.

For Baltimore, the clay is procured at Federal Hill, near the city, and the same clay is sent, also, to Philadelphia, for which city it is also sometimes obtained up the Delaware river.

It must, in all instances, be free from stones and iron rust, and organic matter; it must be white and clean, and it should crumble and form a homogeneous paste with water. It is broken down in water, by a hoe, with a perforated blade and a long handle, and it is strained through a copper kettle, whose sides and bottom are pierced with holes, so as to permit the finely divided clay to pass, free from foreign bodies, that may have been accidentally mixed with it.

The argillaceous pulp is poured upon the Sugar after the latter has become solid in the moulds, and after its roughnesses have been broken down, and the hollows filled with other sugar.

Within two or three days, the caps grow so solid, that they can be lifted off, entire.

The clay caps are then placed in the upper part of the room, next to the ceiling, where they are suspended upon sticks running across under the beams, in the manner of the laths.

When they are perfectly dry, they are thrown into water, broken down and again formed into a pulp, to be used anew, but the acid formed in them must be removed by washing with water.

### *Claying.*

The claying of Sugar is repeated, three or four times, on lump sugar, and two or three times, on bastard sugar.

What is called double refined, in the language of the trade, is, usually, nothing more than the best of the lump sugar.

In order to make that which is really the best double refined, it would be necessary to refine, over again, the lump sugar, or the best white Havana. The latter, would, however, cost too much, as it must, at present, be sold for twenty-five cents per pound, at retail, or the manufacture would be a losing concern.

### *Bastard and Drippings.*

The language of the sugar refiners appears to be tolerably uniform, in applying the term bastard sugar to that which is formed from the first dripping of the lump.

The green bastards, as they are called, stand five or six days, or, sometimes, even two weeks, before they are clayed. The bottom or apex of the cone, is perforated, for a few inches in depth, with an instrument, resembling a marline spike; this is done, for the purpose of letting out the syrup, and when this is discharged, the Sugar is again placed in the mould, and sustained by the pot. For the same purpose the lumps and loaves are perforated, by an awl, or some similar instrument.

The drippings of the bastard sugar form the sugar house molasses.

Those of the lump and loaf go to form more lump and loaf, by a new evaporation and crystallization.

Bastard sugar is sometimes sold in solid masses, but it more commonly is crushed, and appears in commerce as soft or raw sugar, and the greater part of it is consumed in this country. The raw or soft bastard sugar being dry, is often mixed with other sugars that are more moist, and thus it all becomes dry.

### *Sugar Moulds and Pots.*

Sugar moulds and dripping pots were formerly imported, at a great price, from England, Holland and France, and this ware is still decidedly preferred in the refineries in Philadelphia and Baltimore. The English ware is smoother, firmer and stronger than the American, but is much more expensive. The moulds and pots are now made at Norwalk, in Connecticut, by Quintard and Chichester; they are made also on Long Island, and are extensively used in New York, but much less in the cities south.

Clay, from Long Island and New Jersey, is mixed with sand in such proportions, learned by experience, as will produce after suitable baking such a degree of firmness, that the moulds will not break, with the slight blow or jar, which is requisite to detach the lump or loaf, so that, when the mould is inverted, the loaf of sugar will slide out entire.

The prices of the moulds are 90—60—20 and 18 cents, each, according to their size, and of the pots 46—30—11 and 9 cents; these are the prices of the Connecticut ware.

### *Blood.*

Of all the clarifying agents, blood is the cheapest, and it is also very effectual.

In an establishment, working 1,000,000 of pounds of sugar per annum—the blood would cost, as we were assured by an experienced manufacturer, one dollar per diem, while animal charcoal, for a similar establishment, would cost thirty-five dollars a day. For these reasons, and on account of the facility of obtaining a sufficient supply in cities, blood is still generally used in the refineries of this country.* Usually about ten gallons of fresh blood are required for 5,000 or 6,000 pounds of raw sugar, or,

* This gentleman's experience related to a period some years since.

for sugar of a worse quality, half a barrel of blood to 3,500 pounds of sugar. When the blood has been recently drawn from the animals, and is used with all convenient expedition, there is nothing particularly offensive in the process; there is, indeed, in the premises, and especially around the boiling coppers, and the scum cisterns, a peculiar animal odor. This, with the dark, almost black, masses of coagulated animal and vegetable matter, from which the syrup flows, and finally exudes, slowly, by pressure, is, when first seen, rather revolting to the feelings of those who have known only the rich and beautiful product of refined sugar, white, brilliant, grateful and nutritious. Still, in a manufactory, conducted with proper care, there is not, in cold weather, any odor of putrefaction. When the weather is cool, it is not necessary that there ever should be any thing positively offensive, and when the blood is not immediately used, it is kept under lime water, which, as is thought, counteracts its tendency to putrefaction.

In one manufactory in Philadelphia, they informed us, that they found no difficulty in keeping blood, provided they scattered over its surface, the solid chloride of lime. This soon dissolves and preserves the blood, entirely free from taint; for, although applied only on the surface, its energy quickly pervades the whole mass. We did not, among all the great cities, which we explored, meet with any instance of blood used in an improper state, and we presume that such cases are now very rare. Still, we are constrained to believe, that they have not entirely ceased; for we have, occasionally, met with a lump of the sugar of commerce, which, when broken, exhaled the odor of animal putrefaction; and as it could not be derived from the elements of the sugar, it must, undoubtedly, have been the result of an imperfect separation of the blood, or other animal matters, used in clarification. From the same very respectable gentleman, already quoted, who, after thirty years of occupation in sugar refining, has retired from the business, we learn, that, formerly, his German workmen were not very scrupulous as to the condition of the blood, and it was, not unfrequently, offensive. In summer, especially, it was sometimes in a state so near to putrefaction as to be occupied by the vermin which are hatched and nurtured by that process; still, the workmen did not hesitate to proceed with their operations, believing that, by the coagulation and exhalations, produced by the heat, every impurity was effectually purged away, and that the syrup, defecated and concentrated by evaporation, afforded, still, only pure sugar. It is not incredible that such may have been the fact, where great skill and circumspection were exerted; it is even possible that *all* the animal matter present may have contributed to the clarification, but every one would prefer that it should be in a state neither noxious nor offensive. A manufacturer who had formerly used blood extensively, assured us that, in warm weather, it was always offensive, and that even when drawn fresh from the animal, and brought as soon as possible to the refinery, it would, almost invariably, putrefy before it could be used; that it frequently rendered the sugar house very offensive, and although the German workmen generally employed in these establishments, rarely regarded these effluvia, he had known them to faint and fall from the excessive fetor.

The taint of blood is much more apt to contaminate the bastard and the other coarser products of the sugar house, than the highly refined sugars, and the molasses is still more prone to receive this disa-

greeable impregnation; it is, however, in a great measure, removed by the use of ivory black, or animal carbon.

A manufacturer, of great experience, stated to us that, in consequence of a peculiarity in the odor, he could almost always distinguish the sugar that had been refined by blood. To the sense of smell, in common observers, it would certainly not be apparent; great practice, as happens in all arts, had doubtless quickened his.

### *Eggs and Milk and Isinglass.*

As albumen is the principal clarifying agent in the blood, and as in consequence of its ready coagulation by heat, it acts, mechanically, to entangle, and by its attraction it acts, also, chemically, to remove the coloring matter, and other foreign principles from the syrup, we should, of course, expect that other substances containing albumen would produce a similar effect; therefore, eggs and milk answer very well. Formerly, solitary coasts and islands, frequented by sea fowl, were visited, to obtain birds' eggs for this purpose, and vessels laden with them passed up the Thames to London.

But for large operations, eggs and milk are far too expensive. Occasionally, however, for small parcels of Sugar, intended for particular purposes, eggs are used; from 1,000 to 2,000 hens' eggs would be required for an ordinary day's work: 2000 would be sufficient for two pans, capable of holding together 5,000 or 6,000 pounds of raw sugar.

The French writers make mention of separating the whites from the yolk, and of using only the former; they also speak of removing the coagulum or clot from blood, and of reserving only the serum or albuminous portion for clarification; but it is presumed that such pains are rarely taken any where; certainly not in this country, and we have been assured that when eggs are employed, the practice is to crush the whole together, as all the parts are supposed to aid in the process of clarification, and the refiner must thus take the chance of using a portion of spoiled eggs, which, when so many are required, must always, to some extent, be expected. A refiner of high standing in Baltimore, gave it as his opinion, that a single rotten egg would ruin many pounds of sugar; it should be stated, however, that he had never used eggs in refining; and another refiner in New York, who had occasionally employed them, stated that he paid no attention to this point, and that no inconvenience resulted. If he had fallen into no mistake in his statement, it must be set to the same account with the use of putrid blood—the filter and the evaporation, by their united effect, removing every thing injurious or offensive. Isinglass or fish glue has been sometimes employed in clarifying sugar; its purifying tendencies are well known, but it acts upon a different principle from albumen; it is not coagulated by heat, but its inviscating properties and its attraction for coloring matter and for various vegetable principles, enable it to produce a similar result. It is not, however, so far as we know, used to any considerable extent.

### *Blue Paper.*

Refined sugar is always papered for sale, except when it is previously broken up, which, we believe, is rarely done in this country.

Paper for the wrappers is now made near Boston, by Tileston, Hollingsworth & Son. The blue paper is sanctioned by long use, and was probably introduced on account of the contrast of its color with that of the sugar, thus making it both to appear whiter, and to assume a shade agreeable to the eye, as milk or refined sugar is more beautiful when seen through blue glass.

### *Laborers and Foreman.*

In most of the sugar houses, Germans are still employed;—in some exclusively, as is the case also with Frenchmen, in some of the French houses. The business is arduous, and requires the sobriety, subordination and patient and skilful care for which the Germans are generally distinguished. In one of the New York sugar houses, the laborers (all German) receive from twenty to twenty-five dollars per month, with a house and rooms, but they board themselves, and it is in the agreement, that they shall all be without families. It is indispensable that the foreman be very intelligent, active, trustworthy, and of great experience and good judgment. In the case now before us, the foreman receives $500 per annum, besides $50 more as a present at Christmas, or new year. In this house, as we believe is generally the fact in the sugar establishments which we visited, the men, either by stipulation or voluntarily, abstain from ardent spirits, and use, as their common drink, the sugar house ale.

### *A French House.*

In general, the sugar refiners in New York have not adopted the modern improvements. We have, however, seen animal charcoal used in some of the establishments in that city.

We visited a French sugar house in which steam was used, for heating the syrup, but not for evaporating. The heating was done in a large wooden cistern, containing a mixture of the syrup, and of the clarifying agents; the nature of these was not explained, although it was obvious from the blackness of the unfiltered syrup, that animal charcoal was used. Portions of the syrup were drawn off, after filtration, and presented to us as specimens; the fluid was almost perfectly limpid; there was, however, a very faint tint of yellow, and a slight peculiarity of taste. If this manufacturer had secrets, he did not care to impart them. We thought of chlorine and its preparations, but have not, in any refinery, perceived by the odor, or any other indication, that they are employed. This gentleman appeared to be acquainted with the subject of chlorine, and not improbably knew that it was, some years ago, applied in France to the refining of sugar, although it seems to have been subsequently relinquished.

We may add a few remarks on that subject near the conclusion.

### *General state of the Refineries in New York.*

The sugar refineries in this city are not in a prosperous condition, because raw sugars are high; the white Havanna costs from eight to ten dollars by the hogshead, at wholesale; and the prices which the manufacturer obtains are low.

Many manufactories, and, indeed, most of them in all our larger cities, have for the present suspended their operations; and are doing nothing, except to sell out their old stock, while they are waiting for a more favorable state of things. This statement is to be considered as applicable to the winter of 1832–'33.

At present, (May 27, 1833,) there is a considerable revival in their affairs, owing to the return of the season for business.

*Quantity of Sugar refined, annually, in New York.*

When the business is active, the quantity of raw sugar, estimated by an experienced manufacturer, is about 9,000,000 of pounds, answering to about half that amount of refined sugar. This was supposed to be distributed among the different principal manufactories in the following proportions, which, as well as the entire amount, are to be regarded merely as approximations, and not as numerically exact:

| | | |
|---|---|---|
| 1,160,000 pounds, or | 3,000 to 4,000 pounds per diem, | |
| 900,000 pounds, or | 3,000 per diem, | |
| 1,500,000 to 2,000,000 pounds | 5,000 to 7,000, | |
| 1,500,000 | - - | 5,000, |
| 1,250,000 | - - | 4,000, or rising, |
| 1,500,000 | - - | 5,000, |
| 1,000,000 | - - | 3,000, or rising. |

The above estimate is upon the working days. The gentleman who furnished the estimate, was, for thirty years, occupied in the business of refining sugar, and he gave, as the result of his experience, that from one hundred pounds of raw sugar, there were usually obtained:

50 to 56 pounds of refined,
25 pounds of bastard, and
25 of molasses—

without allowing for waste, which other refiners estimated at three to five per cent.

Another statement, made to us by a skilful refiner, gave forty-five per cent as the average of the yield of refined sugar, and of the remaining fifty-five, twenty-five was bastard—twenty-five molasses, and five dirt and waste.

## PHILADELPHIA.

We have already, in connexion with a similar establishment in New Orleans, mentioned the important manufactory of Canby and Lovering, in Church Alley, in this city, which, like that of the Steam Congress company in New York, is conducted upon the principle of the vacuum. There are, we believe, twelve refineries in Philadelphia, including a new one, upon the improved process of the vacuum, which has, recently, gone into operation. Most of these establishments, owing to causes that have been already stated, are, at present, but partially active. Eight out of the twelve have adopted animal charcoal, and four do not use it.

All of them, except the two upon the improved vacuum process, use lime water, blood, and clay; and, therefore, the charcoal is regarded as only an auxiliary to the old process, managed by means of the above named substances. The quantities of raw sugar, refined by all those houses, excepting the new one, not yet in operation, are about 14,000,000 of pounds per annum, supposing them to be all in full activity. Their respective quantities are, per diem, counting four days out of the six working days of the week; 18,000 pounds—8,000—6,500—5,600—2 of 5,000—3 of 4,000 and 1 of 2,000. Their general average produce of refined sugar, is 55 per cent. to 45 bastard, molasses and waste.

At present, (May 27, 1833,) five of the Philadelphia houses are not at work; one is doing one-third work—four are doing half work, and two full work; but it is in the lowest kinds of goods; that is, boiling molasses into sugar.

*Refinery of J. G. Smith & Son, Vine Street.—Its general neatness and good order.*

This establishment is worthy of being distinctly mentioned. It is entirely on the old plan, and in it, no one of the modern improvements has been adopted. The building is spacious, airy and clean; the premises are white washed; perfect method is obvious every where, and there is no smell of animal matter, or of any other disagreeable effluvium. This refinery, which, excepting one, is the largest in the city, sufficiently proves, that even with the use of blood and clay, it is possible to preserve perfect order and cleanliness, and to exclude every thing disagreeable. The filthiness of some establishments is evidently unnecessary, and it would be equally for the reputation and interest of the proprietors, to correct it. This it might indeed be more difficult to effect in very narrow, low and crowded premises; where the clamminess of damp sugar and molasses, and of exhalations, often filling the apartments with a dense cloud of vapor, causes every thing to adhere to the beams, walls, floors and stairs; and the two latter especially are often loaded with ridges of dirt; indeed, in some of the refineries, every thing is so plastered with dirty sugar and molasses, that it is next to impossible to make the circuit of the rooms and examine the processes, without incurring great inconvenience to apparel, and the necessity of thorough ablution when the visit is over. As far, however, as we observed, these unpleasant circumstances were found chiefly in old and other narrow and inconvenient buildings. A sugar refinery, whose business is large, in order to be neat, orderly and comfortable, requires ample room.

*Lime Water Cistern.*

In the sugar house of J. G. Smith & Son, the lime water cistern, being out of doors, is covered from the weather, although it is not excluded from the access of the air; for the same crust of carbonate of lime, which has been already mentioned, as covering the lime water in the open cisterns, was observed here.

They use, here, one bushel of lime for sixty hogsheads of water, which suffice for one refining, occupying about fourteen days; of these, eight are employed in the refining, properly so called—five for the production of the bastard sugar, and one for cleaning up.

### *Drying Stove.*

The drying stove is, here, of great magnitude; it extends through five stories, and is from forty to fifty feet high, and fourteen feet long by ten wide.

The lumps and loaves are, in this refinery, all papered, before putting them into the oven; this preserves them from being soiled by dirt, and by handling. The lumps remain twenty-five days in the drying stove, and when they are withdrawn, they stand two days, on the dome of the kiln, outside, the base of the sugar cones being down. The object is, to diffuse, equally, through the entire lump, the small portion of colored syrup, which still soils the little end; this gradual flow is facilitated by the heat of the oven, and when it is finished, the lump has a uniform tint.

In sugar refineries, it is not unusual, to knock off the small colored end, and to use it over again, in refining other parcels.

This company appear to manage their processes, and their entire establishment, with great good judgment, skill and efficiency. They obtain two or three crops of lumps or loaves, before they reserve the syrup for molasses, which comes from the draining of the third set of loaves, or lumps; from this molasses they obtain the bastard sugar. In this manufactory, when in full operation, they work about eight thousand pounds of Sugar per diem for each of their working days.

### *Refinery of Paul Lajus, & Co., Bread Street.*

This establishment was, until recently, carried on, upon the old system, but it has been, entirely, remodelled upon a French method. The workmen are all French, who came out, on purpose, to manage the business of the manufactory, which retains only one feature of the German method, and that is, the use of blood, in certain cases, and to a certain extent.*

This manufactory is, apparently, one of great excellence. We do no speak of it in relation to profit—which, as it has been in operation but a short time, there has hardly been sufficient opportunity to ascertain. There seems, however, to be no reason why it should not, in this respect, sustain a competition with the best establishments. Its machinery and arrangements evince superior judgment and skill, and its police appeared to be of the best kind. It is not intended, by the proprietors, that access should be obtained, by visiters, to this refinery, but to us every thing was confidentially shewn and courteously explained. The confidence reposed in us, we will endeavor not to violate, although, we believe, that similar establishments exist elsewhere, and that every important fact to be learned here, is now well known.

Howard's apparatus does not exist here; there is neither air pump nor vacuum—neither steam tubes nor steam engine.

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*At present, May 27, 1833, they have replaced the French by German workmen, only they retain a French foreman.

### *Its Fixtures.*

The furnaces, standing on the ground floor, are fed by bituminous coal. The boilers, which are of the usual size, stand so high that their contents will run off, into the filtering boxes.

From these, the filtered syrup is pumped up into a cubical box of wood, lined with copper. This is so elevated, that the syrup flows, readily, into the evaporating vessels—which are the (now well known,) bascule pans, called also, tilt or see-saw pans.

Concerning these, which, being common in Louisiana, on the plantations, and already mentioned in this account, we are free to say, that they are greatly superior, as evaporators, to the fixed copper boilers, used in most of the establishments. Being swung upon chains, they are, with great ease, raised, lowered, tilted, and, in every way, managed, over the fire; the evaporation is rapid, and can be terminated, at any moment, by pouring out the syrup, by a slight inclination of the bascule, the liquor passing off by its spout. This renders it possible to manage even a rapid evaporation with safety; and nearly, obviates the danger of too great a degree of heat.

### *Clarification.*

In clarifying, they employ both animal charcoal and blood; of the latter, not half the quantity, usual in the old mode; and the management is substantially the same that has been already described. The principal reliance is placed upon animal carbon; they use blood only when they would wish to make very fine sugar; for coarser sugars, they employ animal charcoal alone; about ten per cent., more or less, according to the quality of the sugar. Lime water is not used.

The contents of the boilers or pans—namely, syrup and charcoal and scum of blood, when the latter is used, all flow together into the filtering boxes, where the syrup passes, many times in a day, through cloth; and the blood-scum aids in detaining the fine particles of charcoal, which float in the liquor, and which it is difficult, otherwise to arrest.

### *Filtration and Pressing.*

The filters are washed, once a week, as in other establishments, and the washings are saved for future use, in the clarifying pans.

The scum is pressed, not as already described, in other cases, by a rope twisted by a stick around the neck of the containing bag; but by a much stronger pressure, is applied in a screw press, which appears to be a far better process, although, it is said, that those accustomed to the old mode, prefer it. The fluid which exudes goes again to the clarifying pans.

### *Moulds and Granulation.*

The moulds are of English ware; they are filled, as in other manufactories, and the syrup is stirred in them, to aid its granulation, or, in other words, to prevent the formation of large crystals; they do not wait for the granulation to take place in the copper coolers.

The pots are washed, in a large wooden vat, and the washings when reserved, are, probably, used by the distillers, or for the formation of vinegar.

Formerly this kind of refuse was sold at one dollar a barrel; now, however, it is often thrown away, as it is at best a foul and poor fluid.

### *Oven for Sugar Candy.*

There is a room for forming sugar candy. It is a small apartment of brick, and is warmed by a stove, for the purpose of evaporating the syrup, gradually, uutil it will crystallize. The syrup is made very strong, and threads are suspended in it, around which the crystals form. They, if coarse, take their color from that of the syrup, and, sometimes, coloring matter is added, on purpose, to impart a particular hue. As in other cases, the size and perfection of the crystals depend on a gradual and long continued evaporation, usually four or five days.

The candy is, sometimes, made in the common drying oven. Canby and Lovering have, heretofore, made it in that manner; their drying oven is warmed by steam tubes, and although it rises through six stories, it can be readily heated to 200° or more, and this degree of heat is sometimes used by them; they can then readily make the sugar candy.

### *Slide for the Clay Caps.*

We observed a convenient contrivance for returning the caps from the upper stories or lofts, where they have been used, to the ground floor, where they are to be worked over again. It is a tube formed in the masonry—furnished with a door, and communicating from the highest to the lowest story; the caps, being thrown in at the upper hole, of course, slide down to the lowest floor.

## BALTIMORE.

### *General state and prospects of its Refineries.*

In this city, as well as in others in the United States, the business of sugar refining is in a depressed state. It is imputed, by the refiners, to the duty existing, especially upon clayed sugars, and to the rival efforts in Louisiana, to supply the country, with refined sugar from the native production of that State—great quantities of which have been, during the past year, thrown into the market, and the refiners are fearing a still greater flood from the same source.

It is not our duty or intention to meddle with the vexed questions of public policy on this subject; but we may, without impropriety, add, that the reduction of duties already commenced by a late act of Congress, and which, if the plan be not changed, will proceed, year by year, until the minimum is obtained, will, as far and as fast as it goes, afford the desired relief to the refiners, both as regards the first cost of their material, and the equality of competition. At present, the refiners at New Orleans, enjoy the benefit of their native sugar, which they can, of course, obtain at a cheaper rate than it can be purchased in the Atlantic cities. The Baltimore refiners estimate this difference, in the

present state of the market at two to three and a half dollars in the hundred pounds of raw sugar—taking the price at New Orleans, for the raw sugar of Louisiana, at three to four dollars per one hundred pounds, and in Baltimore at seven to seven and a half.*

There are, in Baltimore, nine sugar refineries, six only of which are in operation, and that only upon a partial scale.

These establishments are estimated to be worth $120,000.

In former years, from nine to ten millions of the clayed sugars of Cuba and Brazil were annually refined in Baltimore; during the last year, but two or two and a half millions; at the largest estimate three millions; and a still greater decline, if not an extinction of the business, is feared by the refiners.

The buildings and apparatus are scarcely applicable to any other purpose, and, it is supposed, by those most nearly interested, that the entire failure of the business, in Baltimore alone, would produce an annual loss of $100,000.

The quantities of raw sugar, at present, refined in Baltimore, are, by the estimation of an experienced manufacturer, for the six houses that are in operation; the largest six hundred thousand, to one million pounds—three others of five hundred thousand pounds, each—one of three hundred thousand, and one of two hundred thousand.

The manufacturers would be content, either with another cent added to the five now allowed by government on re-exported refined sugar, or with the removal of duties on imported raw sugars.

### *Nature of the Establishments.*

The sugar refineries of Baltimore are all upon the old plan. There was here, a few years since, a large steam and vacuum manufactory; it belonged to Mr. D. L. Thomas, and having been destroyed by fire, and the proprietor removed by a tragical death, it has not been rebuilt. It was, at the time of the accident, going on very successfully, as regards the quality of the sugar, which was most beautiful. The impression, however, among the manufacturers of sugar, here is, that it was a losing concern, and that, at the end of two years, it had sunk a considerable proportion of its capital, although Mr. Thomas was a man of great vigor and industry. We mention this, as an instance of the impression which we find to be general, among the refiners who proceed upon the old plan, namely, that the new process by steam and the vacuum pans, if not ruinous, is, at best, so expensive, that its success, unless prosecuted upon a great scale, is very dubious. Although we possess confidential information, which enables us to form a decided opinion on this question, it would, even if we were at liberty, still be best to leave the subject to be settled by the great experiments upon the improved plan, which are now making in this country, and of which the result must, ere long, be fully known.

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*As stated in a document furnished to us, by the principal refiners in Baltimore, and signed by them.

### *Refinery of G. W. and H. Miller, Concord Street.*

Although at the expense of some reiteration, we will mention some particulars respecting this manufactory,—taking it as a favorable example of the management in Baltimore, which being, at present, exclusively upon the old plan, will need no other demonstration than what is presented by this single case.

They consider the New Orleans raw sugar as being one-fourth less rich in saccharine matter than that from the Havanna: an opinion which we are persuaded has grown out of a comparison of unequally drained sugars. White sugars are, here, frequently mixed with the brown, for the purpose of raising the quality of the latter.

### *Process of Purging and of Clarification.*

The order of mixture, in this manufactory, is, to place the sugar first in the pan,—then the lime water, and then the blood: they are all mixed, over night, and the next morning, as early as two or three o'clock, the workmen light the fire, and give the pan, not a boiling, but a simmering heat; in the mean time, they agitate the whole together, with a wooden instrument, shaped like an oar. The fluid is then allowed to remain quiet, and the coagulated blood and impurities, form, together, a mass, whose crust is so firm, that a mouse could run over it without breaking through. By the peculiar appearance of the scum, and by the sound, which it is not easy to describe, the experienced boiler knows when the work is done.

### *Blood.*

In general, one gallon and a half of blood is a sufficient supply for one hundred pounds of raw sugar, and five or six gallons suffice for a day's work.

The blood is always obtained fresh, and, as we were assured, is never used here, in a putrid or even tainted condition. They attempt to counteract the tendency to putrefaction, by throwing a little lime upon the blood, but they did not appear to be acquainted with the superior efficacy of the chloride of lime. The blood is passed through copper kettles, pierced with holes, so as to separate any foreign substances, and the larger masses of the crassamentum, and to leave the serum or albuminous portion, in greater purity. To make the lime water, they add one bushel of lime to three thousand gallons, or nearly one hundred barrels of water.

### *Straining.*

As in the other sugar houses, upon this plan, the syrup is strained in blankets, and they are here suspended, in a large square basket, which stands so high, that even the bottom of the box or recipient, into which the filtered syrup falls, is on a higher level than the lip or rim of the evaporating copper. The liquor, therefore, flows readily through a tube

and thus they avoid the trouble of lading or pumping it, the second time, to convey it to the boiler.

### *Drying Oven.*

The drying oven, in this establishment, extends through five stories, commencing on the ground, where the stove is placed. The cavity is twelve feet long, eleven feet wide, and from forty to fifty feet high: a moveable grating of wood is laid, from side to side, on the shelves, and answers for the men to work upon.

This oven, often, contains three thousand loaves, answering to eighteen or twenty thousand pounds.

All qualities of sugar are here papered, before they go into the oven; the drying occupies three or four days, and all the refining processes, from beginning to end, take from eighteen to twenty-five days.

As happens, elsewhere, the pots and moulds are usually English: those of Connecticut are sometimes used, but are not considered as being equally good.

### *Furnace for Warming.*

There is a furnace in the lower part of the building, which supplies heated air to every part of the house. The tube in which the hot air rises, is furnished with an iron door, opening into every loft, and thus the heated current is either excluded or let in, at pleasure. This is for the general warming of the house.

### *Claying.*

It requires a very warm atmosphere to promote the more perfect fluidity of the adhering syrup, and, of course, to insure its ready percolation during successive clayings. In that simple but curious process, by examining the lumps or distinct intervals, we can trace the descent of the colored syrup; the upper part or broad base of the inverted sugar cone, is first cleared of the color, which as the water from the successive clayings descends, travels farther and farther down, towards the vertex, where, alone, it will, finally, linger; from this point it is often difficult to dislodge it, entirely, without dissolving too much sugar, and wasting too much time; it is, therefore, frequently knocked off, for a few inches from the point, and refined over again.

### *Conductors for the Drippings.*

There is, in this house, an ingenious arrangement for conveying the drippings of the syrup, from the upper stories to the lower. On each floor of the building, where the sugar is clayed (and it is always done in the upper stories, both because they are the warmest and are also secluded from other operations)—the earthen pots, which receive the drippings, are emptied into a wooden box, from which, a tin tube, three or four inches in diameter, descends to the top of the box, in the story next below, and from the bottom of that, proceeds another, and so on, until the last tube reaches the evaporating pans, into which the syrup is destined

to flow. Each box is furnished with a moveable lid or cover. The blood-scum is pressed in bags of twilled hemp.

*Thermometer.*

The evaporation of the syrup is regulated by a thermometer, a precaution which is too generally neglected in our American refineries. In the present instance, a thermometer, whose tube and scale were two or three feet long, so as to give very large degrees, which can be the more easily read through the vapor, was suspended, so that its glass ball, protected by a metallic ring, was situated in the syrup, while its scale was defended by a case of wood. The evaporating heat is usually 230° to 240°; the poorer the sugar, the higher the heat—sometimes it rises as high as 270°.

*Water and Clay.*

This establishment, like those in Philadelphia, is, abundantly supplied with water, from hydrants; it is conveyed by tubes of lead, and drawn in every part of the building, where it is required.

It has been already mentioned, that the clay is obtained from the Federal Hill, in this vicinity.

The claying is generally repeated three or four times. In the summer, the clay-caps are prone to become sour, and are sometimes rejected; but, in general, the sourness is removed by washing with water; and the clay can be used again. Claying is here preferred to liquoring, which was thought, by Mr. Miller, to be expensive, and less effectual; but other manufacturers, with whom we have conversed, are of a different opinion.

*Bastard.*

The bastard sugar is formed from the drainings of all the crops of lump sugar, that have preceded; it is generally obtained about the seventh or eighth day of the processes, and is not redundant so much in what may be strictly called impurities, as in other vegetable principles; the proportion of saccharine matter in it, is decidedly less, than in lump and loaf sugar.

The bastard sugar is, occasionally, clayed, and made into an inferior lump sugar. In that state, it is sometimes sold, or, at least, the broader part of the lump, which is most free from the coloring syrup, is vended. More commonly, however, it is not clayed, but it is crushed, and sold in the powdery state, as raw or brown sugar. It is, sometimes, clayed even when it is to be crushed;—the crushing is done by pounding, or by machinery.

Particular lots of bastard sugar are, occasionally, clayed, twice or three times; the best of it is sold, as lump sugar, or, more generally, it is worked over again, to make sugar of a higher quality. There is a kind called piece sugar:—it is better than the bastard, and is often bought by country tavern keepers, and by others, who wish a cheap lump sugar, for both the piece and the clayed bastard are sold in large lumps.

A statement, made in one of the refineries in New York, was here con-

firmed; namely, that the best of the single refined, is often sold for the double refined; but, the real double refined is made from white Havanna, or by working over again the single refined, and carrying it through all the various processes.

### *State of the Copper.*

In this refinery, the mason work around and between the boilers, instead of being covered, as is usual, with sheet lead, was protected by sheet copper.

This copper was perfectly bright and clean. The same fact has been observed in all the copper pans, evaporators, and copper apparatus of every kind that we have seen, in all the establishments, which we have visited. In no one of them, has there been observed the slightest green coating, or any other evidence of corrosion, or of the generation of acids, in any part of the operations on sugar.

This fact seems very unfavorable to the supposition, that there is any considerable portion of acid in sugar, and, therefore, it appears probable that the lime water aids more in the coagulation of the feculencies, than in neutralizing acids.

It is true, that copper, brass and bell metal utensils, are often cleansed by acids, and that they are also employed in families, and by the confectioners, for preparing jellies and preserves extracted from acid fruits; and the vessels are not corroded. They are, however, used rapidly, and the charge is not allowed to stand in them; they are immediately cleaned and dried, and no chemical action takes place upon the metal; were the materials to stand in them, they would soon be corroded, and become green, as the various instruments of copper would do in the sugar refineries were there any considerable quantity of acid.

### *Washings.*

The washings of the pots and cones, as already remarked, are often used for vinegar; the weak saccharine fluid, thus obtained, ferments spontaneously; at the moment when we observed it, the fermentation was active, the mass of fluid being agitated by a brisk internal movement, arising from the extrication of carbonic acid gas; in this way, it clears itself and becomes good vinegar. Sometimes cider is added to it to increase the product of vinegar.

### *Kinds of Sugar.*

The kinds of sugar known in the language of trade, are, according to the statements made to us:

1. *Family or loaf.*—This is the best double refined—cost, at this time, seventeen or eighteen cents per pound; at wholesale sixteen and a half cents.

2. *Lump.*—Quality 1—2—3—descending, for each, about one cent in the pound; all these are called lump sugar, and are those commonly known by that name, and possessing different qualities.

3. *Piece.*—Inferior to lump—superior to bastard.

4. *Bastard.*—Inferior to piece—the lowest variety known in the sugar houses.

Sugar house molasses closes the series of saccharine products.

### *Permanency of Sugar.*

Sugar, when dry, is very little liable to spontaneous changes, and suffers no waste. It is, therefore, a very safe article to keep on hand. In the establishment, now under consideration, there were, at the time of our visit, twenty thousand loaves, worth, at least, that number of dollars.

This is the most convenient building that we have seen among the sugar refineries. There is sufficient height between the floors and ceilings, to enable persons to pass without inconvenience; the interior is plastered—the premises are clean, free from offensive effluvia, and excellent method pervades every department.

## THE EASTERN STATES.

Sugar refining is not, in this portion of the United States, pursued, to any considerable extent, as a branch of industry except in Boston and Salem. Some minor establishments,* which have either ceased or are prosecuted on a very small scale, will not claim our attention. It will be sufficient to present a very condensed account of the refineries in Boston and Salem.

The establishments in Boston, were visited and critically examined, by Mr. O. P. Hubbard, scientific and practical assistant in the chemical department of Yale College—with the aid of gentlemen on the spot, who possessed an intimate knowledge of the subject. The results are digested under appropriate heads, and are now presented in a very condensed form; after the full details that have been already given, they will, in this state, be intelligible; while the repetition of some things, common to these and similar establishments that have already been described, will not be without utility; because there are, in all the refineries, points of difference, in the manipulations and management of similar processes, which are sufficiently instructive and important, to compensate for some partial reiteration.

### *Notices of the Sugar Refineries in Boston and Salem.*

The statements are drawn from the establishments of Messrs, Doane, Andrews and White, of Boston.

### *Quality of Sugar Refined, and the country from which it comes.*

Mr. Doane prefers two-thirds brown Havanna, and one-third Siam or Manilla.

Mr. Andrews uses chiefly brown Havanna.

Foreign sugars are preferred to American—as in case of re-exportation after being refined, the drawback of five cents per pound is paid by the government.

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*If we are not misinformed, there have been, heretofore, refineries in Providence, Rhode Island, and in Portsmouth, New Hampshire.

### *Market.*

Mr. Doane ships about fifty thousand pounds of sugar to Lima and Valparaiso; and sends seven-eighths of his molasses to Philadelphia.

### *Amount refined, annually, and the per centage of different products.*

| | | |
|---|---|---|
| Mr. Doane refines | 300 | tons, annually. |
| " Andrews " | 300 | " " |
| " White " | 130 | " " |
| Salem refinery, | 200 | " " |
| Total | 930 | tons—about 2,000,000. |

Mr. White furnished the amount for Salem.

### *Products.*

Loaf sugar is not made—the demand is so limited, that one day's work in one refinery, would supply it.

### *Mr. Doanes' Refinery.*

| | | | |
|---|---|---|---|
| Lbs. | 350,000 | of Lump, worth | 12 cts. |
| " | 45,000 | of Facings, worth | 10 cts. |
| " | 90,000 | of Brown Bastard, worth | 9 cts. |
| Gals. | 21,000 | of Molasses, worth | 40 cts. |

### *Mr. Andrew's Refinery.*

| | | |
|---|---|---|
| 300 | tons=672,000 lbs. of raw sugar, yield | |
| 60 | per cent. of Lump=403,200 lbs. 12 cts. | |
| 12 | " | Brown Bastard=80,640 lbs. 9 cts. |
| 25 | " | Molasses, |
| 3 | " | Loss, |
| 100 | | |

With this, as a standard of comparison for the refineries of Mr. White, and of Salem, their results may be thus stated, viz:

| | | |
|---|---|---|
| 330 | tons=739,200 lbs. of raw sugar, yield | |
| 60 | per cent. of Lump=443,200 lbs. 12 cts. | |
| 12 | " | Brown Bastard=88,704 9 cts. |
| 25 | " | Molasses, |
| 3 | " | Loss, |
| 100 | | |

In comparing these results with those of Mr. Doane, it appears that Mr. Andrews, from the same amount of raw sugar, makes a greater quantity of "Lump"—and has no "Facings."

These are the bases of the "Bastard" loaves, to be mentioned more particularly hereafter.

The "Facings" are of a tolerably fair quality, and are saleable at the north, but not at the south; there they are reworked with the brown sugars, here it is better to sell them at ten cents, and buy raw sugar at eight or eight and half cents.

*Process.*

Mr. Doane pursues, exactly, the old German mode.

Mr. White, also, the same, without any variation.

Mr. Andrews' mode has some peculiarities worthy of being mentioned.

*Clarification.*

The process of Messrs. Doane and White, is now detailed from our own observations.

The fire is kindled under both kettles or pans; the lime water, in the proportion of one-third. is pumped in; the blood, from eight to ten gallons, according to the quality of the sugar, is added, and, as soon as may be, 4,500 pounds of sugar are thrown into the two pans, through a large trough, from above.

Gentle boiling raises a very dense, offensive, scum, of nearly three inches thick, which is removed by a skimmer.

A second scum is raised, by adding a small quantity of blood and lime water, one bucket to each pan.

A third is produced by adding lime water alone, and, sometimes, even a fourth scum is raised. The clarified fluid is then passed through a blanket filter, which separates the sedimentary impurities; the pans are next scoured, with a broom and sand, and the fluid pumped back, one-fourth at a time, for boiling to a syrup.

Mr. Andrews clarifies in a rectangular cistern of copper. A charge is 4500 lbs. dissolved in lime water, with the addition of two and a half per cent. (112 lbs.) of animal black, and at the same time of six or eight gallons of blood, varying with the quality of the sugar. Heat, generated in a steam boiler,* is communicated by steam, through a copper pipe passing over the side nearly to the bottom and towards the centre of the cistern; and the temperature is raised to 200° or 208° F. The fluid is constantly stirred with an oar; the process continues for two or two and a half hours; the scum is removed and washed with boiling lime water, to be used at the recharging of the cistern for a new clarification, and the "black" settles at the bottom. The fluid should be of the density of 32° of Baumé's aéreometre, and is then drawn off clear by a "float" constructed in the following manner—see Fig. 2.

Suppose the cistern to be full of the clarified liquid to a, and the

* A blowing machine was introduced to pass hot or cold air over the pans, to aid the evaporation; but it was unsuccessful.

sphere B, of such size and weight as to float at any elevation. When the stem C is vertical, the passage through the joint D, is shut as a security against the unseasonable exit of the fluid. On depressing the sphere so that some of the liquid may run into the tube C, at the orifice a, the surface is lowered and the tube, before erect, now turns on the swivel joint D, and becomes inclined; the passage is opened through D, and the fluid is gradually discharged through the tube C, and stop cock F, into the filter which is fixed in a lower story beneath.

Fig. 18—*Baumé's Aéreometre or Saccharometer,*

Is of glass, hollow throughout; the tube of the upper part contains a scale, graduated from 0°, the point to which it sinks in pure water, to 32°, the point of density of the fluid proper for filtering. The globe below is weighted with shot.

Fig. 16—*Taylor's Filters.*

These are employed in Mr. Andrews' refinery, and are enclosed in a strong box about six feet high, and two or two and a half feet square. Fig. 3 represents a vertical section of this filter. In the upper part of the box is a cistern of copper, A, one foot deep; the bottom is pierced with a dozen or more holes or screw taps, c c c c, &c. of an inch in diameter; into each of these is screwed a perforated copper cylinder, D D, which has its lower extremity enlarged; around this is tied, securely, the bag or sack B B B. which is about four feet long, and made of twilled cotton duck, by doubling one width of the cloth.

This sack is surrounded by another of some coarser material, a little longer, but of only one-fourth the size of the inner one, and is confined, when filled with syrup, to the limits of the outer one.

For a more full account of these filters, see "Art du Raffineur, par M. Chandelet, p. 70.

One whole side of Mr. Andrews' filter is removed when the sacks are to be taken out and cleaned; and the hollow cylinders are unscrewed and taken out with the sacks attached. These arrangements are much more convenient than the French mode, in which a small opening only is made in one side of the box, through which the sacks are introduced and removed, and the hollow cylinders constantly remain in their places; and the sacks are secured to them, thus fixed, with much less convenience than if they were attached outside the box, and then properly arranged by the simple operation of screwing the cylinders into their place.

On the introduction of these filters, it was said for them "that their use would remove the necessity of using blood, and economize a great part of the animal black;" but experiments have, (as is thought here,) abundantly proved, that the use of blood cannot be dispensed with, and that there is an economy of more than one-third of the animal black.

The use of these filters confers the following advantages, viz:

1. They occupy less space than the old filters.
2. The syrup may be clarified in a more concentrated state.
3. As the filtration is more rapid, the syrup remains but a short time in the cistern, and can be carried, while hot, to the pans, to be concentrated still farther.

4. There is an economy of a part of the animal black.

Mr. Andrews' filters are not hung in a vacuum, nor is steam introduced among them.

*Animal Black.*

This is made by igniting bones in iron retorts, at a manufactory at Boston devoted to this process only. The "black" is obtained at the time when it is needed for use; no particular pains are taken to preserve it from the air, &c.

The use of "black" is said to allow of the working of a lower quality of sugar.

*Boiling.*

The evaporation of the syrup is managed by a slow fire of bituminous coal; and the boiling rises to only a brisk simmer; butter is constantly used to prevent boiling over.

The "proof," or degree of concentration, is acertained by the "thumb and finger," thus: the foreman lifts the oar out of the syrup and takes up a small quantity on the thumb and finger, which are then brought into contact, and separated, several times, in a range with the eye and a lighted lamp.

The point desired, is indicated by an incipient granulation in the cooling syrup on "proof," which can be immediately discovered by the feeling and the sight.

This mode is represented by Mr. Andrews as the most correct, if not most scientific. As the "proof" varies with every parcel of sugar, the density of the syrup is not a safe criterion—for if boiled too much, in one parcel, the molasses would not run off, making a "stopped loaf"—when boiled "free," the molasses runs freely—more rapidly.

The thermometer and saccharometer, are, therefore, regarded, by him, as unsafe guides, and not used in his refinery.

When the syrup is reduced to a proper consistency for granulation, the fire is checked or smothered, by throwing on fine, wet coal, and even water. The syrup is dipped rapidly into large, handled, copper basins, and transferred to the cooler. This is a large, low, cylindrical, copper vessel, a little removed from the pans, and placed near the moulds. The syrup is stirred, occasionally, with an oar, to cool it equally, and prevent a crust from being formed upon the surface. When cooled, it is dipped again into the copper basins, and the eight lb. or ten lb. mould, which are arranged in parallel rows, supporting each other, are filled to two-thirds their capacity—after an interval of a few minutes, one-fourth is added—shortly after, the balance is added—this last fills the moulds, and is called "trimming." The moulds are now immediately stirred and scraped, on the inner surface, with a narrow flat stick, and after an interval of ten minutes, are stirred again.

After standing in the laboratory till they have become somewhat solid, they are drawn up, singly, in a sling, by a wheel and axis, through a trap door, into an upper story—the rag which had stopped the orifice in the vertex, is pulled out—a hole is made into the loaf with an awl, and each mould is placed upon an earthen pot to drain, aided by the process

of claying. *As soon* as the syrup is put into the cooler, lime water is again pumped into the pans, and the fire (which was checked by throwing on wet coal) is rekindled, a bucket of blood (four or five gallons) is thrown into each kettle, and the sugar is let in from above, as before described, for another clarification.

### *Scum.*

The scrapings, taken off from the floor, are thrown into the scum kettle, and the whole is washed in bags under pressure, with much water, and the saccharine matter is dissolved and preserved for a future process—the scraps are used for fuel, saving in Mr. Doane's refinery, five chaldrons of coal in a year=$45.

The washings of the moulds make vinegar.

### *Claying.*

Lump sugar stands in the moulds, one week, before claying. Pipe clay is broken down and softened with water, in vats, and mixed by an oar—when of the consistency of cream, it is strained through a coarse metallic cullender, or through a basket, to remove any lumps of clay or other substances. A ladle full of this is thrown, on the base of each reversed loaf, forming a cap of an inch, or an inch and a half, in thickness, according as it is the first, second or third claying. These caps, when dried, are removed and reworked in the vats, and rensed again and again.

Each claying occupies more or less time, according to the mode of manufacture, or the number of clayings.

Mr. Doane boils the syrup "freer," or "higher" than formerly, and thereby saves one claying and two or three weeks of time. He clays but twice—each operation occupies two weeks—the cones then stand two days—the base becomes hard, or "gets a face"—they are then reversed—the undischarged syrup settles from the tip through the whole mass—after two days, they are papered and put into the stove for four days, when it is merchantable.

A process occupies about four weeks.

Mr. Andrews clays three times—each operation occupies from seven to ten days.

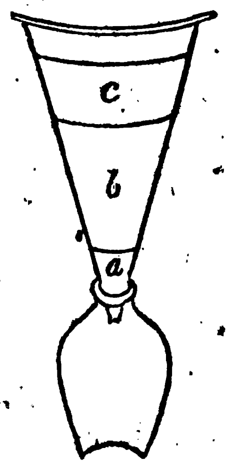
### *Clay.*

This is obtained, of first quality, from Gayhead, and is worth, in Boston, five dollars a ton. It is better than the Holland clay—is not as heavy, is purer, and can be more frequently reworked.

The syrup, which runs from the small loaves, is reboiled to a proper consistency, ascertained as before, by the thumb and finger—no blood is now used,—but instead it is boiled an hour longer—when reduced, it is put into very large reversed cones, called

"*Bastard Moulds.*"

The sugar of these, denominated "brown bastard," is clayed twice, and after these operations, the surface will have sunk from four to six, or seven inches. The whole weighs about seventy-five pounds; and is divided into several qualities of sugar, as marked in the annexed figure, viz: the part (*a*) called "bastard tips," weighing ten pounds—these are very dark colored, and impure—(*b*) "bastard sugar," weighing fifty pounds—this is, sometimes, beaten up; but this mode spoils the grain—it is better, if shaved up with hand shaves, and is then quite fair and bright—(*c*) "facings," weighing fifteen pounds, of fair quality, and so white that it is often shaved up and pressed into four or five pound moulds, and sold as "lump."




The thick viscous syrup, which runs from these moulds, constitutes the *sugar house molasses.*

*Stove.*

This extends through three stories, and has a door opening into each of them. The air is heated by an iron furnace underneath, which is supplied with coal; and the temperature is maintained at 130° or 140° F.

Shelves of rack work are arranged, throughout, giving free circulation to the warm air.

It is desirable to have a summer heat, or, perhaps, somewhat less in the upper stories, where the claying is conducted. To produce this, and to economise heat, Mr. Doane uses close stoves and an additional expedient, viz: at night, when the work of the day ceases, and the furnace and chimney of the laboratory, are still warm enough to elevate, for some time, the temperature of the air, that may pass through them, Mr. D. cuts off the draft of the chimney, by sliding an iron plate across its throat, and then opens, beneath the plate, a little iron door, through which the warm air issues in great abundance into the apartment. With a similar apparatus, in each story, a supply of warm air may be had, whenever desired.

*Laborers.*

Mr. Doane employs six men—one foreman, and five others—*all* Germans—collectively, at about two thousand dollars a year.

Mr. Andrews employs miscellaneous hands.

In neither, is ardent spirits allowed or drunk—beer alone is permitted.

*Fuel.*

Nova Scotia coal is preferred to all other kinds of fuel; and of this, the Sidney coal has preference over the Pictou. As the mines are more

deeply explored, its quality is yearly improving—"it gives a better blast, and has more sulphur," says a refiner.

The bituminous coal of Virginia is considered dangerous, on account of its tendency to spontaneous combustion.

Mr. Hayes, of the Roxbury Laboratory, stores it in layers, alternating with Nova Scotia coal, and thus obviates the danger.

| | | | | |
|---|---|---|---|---|
| | Mr. | Doane uses | 130 | chaldrons, |
| Say the same for | " | Andrews, | 130 | " |
| Proportionally, | " | White, | 56 | " |
| " | " | Salem, | 87 | " |
| | | | 403 | chal. coal, $9. |

*Lime.*

Seventy-eight casks Thomaston lime—$1 to 1 20 is about the supply.

*Moulds.*

A sufficient stock for a manufactory of 300 tons, is 6,600 small moulds, and 600 or 700 large ones.

Those imported from Holland are used, and cost here, including freight, duties and breakage, twelve and a half cents for the small, and from fifty to seventy-five cents for the large. They are made also on Long Island at sixteen and two-thirds cents for the small, and one dollar for the large. English moulds are the best, but they cost much higher. The moulds, when cracked, are not often repaired, as it is considered cheaper to buy new ones.

*Paper.*

Mr. Doane's consumption for a year,

from 12 to 14,000 lbs. blue paper,
4,000 " white "
" 6 700 " American twine.

In proportion for the other refineries,

from 25,200 to 29,400 lbs. blue paper,
8,400 " white, "
" 1,260 to 1,470 " American twine.

*Average.*

40,300 lbs. blue paper,
12,400 lbs. white, "
2,015 lbs. American twine.

*Miscellaneous.*

Mr. Doane's refinery is the only one in Boston, erected expressly for, and fully adapted to the purpose of sugar refining. The building is capacious, the stories of good height, and the different apartments roomy, and well arranged—and a very agreeable neatness and an exact system of operations pervades the whole establishment.

Now, there are in Boston, but three refineries;—ten or eleven years ago, there were seven—at that time, one-half of the refined sugars of New England, was used in taverns and groceries for mixing GROG. The diminution of the number of refineries is attributed to the temperance reformation.

## CINCINNATI, OHIO.

There is a small sugar refinery in Cincinnati, which is the only one we can hear of, west of the Allegany mountains. There was an attempt in Cincinnati, on a larger scale, during the late war with England, but it proved abortive; and what remains of it is now in the hands of a German, who, with great economy and integrity, has been able to make it, barely, a means of living. We learn, from the best authority, that since the patent refined sugar has made its appearance, he can sell but a trifling quantity of his best quality, at fourteen cents per pound. It is manufactured by him in the old way. Even at the price just named, it would, however, be a fair business, if the sales were extensive, and if the raw material could be faithfully and judiciously purchased for him by agents in New Orleans. The expense of commissions and freight, would be amply repaid, by the difference in favor of Cincinnati, in fuel, rent and subsistence, so that with proper arrangements for purchases and sales in New Orleans, no reason appears, why the refining of sugar may not be carried on, advantageously, not only in Cincinnati, but in Louisville, St. Louis, Natchez, and other great towns on the western waters.

The refined sugar made in Cincinnati, is of a pure white, but with an imperfect crystallization, and a feeble cohesion. Great quantities of refined sugar are consumed in green teas, which are extensively used in the west—more, it is said, in Cincinnati than in Boston, and more on the borders of the Ohio, in proportion to the population, than in any part of New England.

It is thought, that the consumption of loaf or refined sugar will not, in the west, keep pace with the progress of population, because of the cheapness of coffee, which, to a considerable extent, is taking the place of tea as well as of ardent spirits; and in coffee, brown sugar is generally preferred. Still, much refined sugar is used to qualify whiskey, which, unhappily, continues to be extensively used in the west by certain classes of persons.

There is in New Orleans a small refinery on the old plan; and one in Charleston, South Carolina; the latter is not at present in operation.

## GENERAL VIEWS AND CONCLUSION.

In concluding, we are naturally led to form an estimate of the present state of improvement in the manufacture of sugar, compared with its former condition.

As regards the manufacture of the raw sugar, from the cane juice, in the first process on the plantations, it is obvious, that, until recently, no very important improvement had, for a long time, taken place.

The account given nearly forty years ago, by Bryan Edwards, the celebrated historian of the West Indies, is, substantially, a statement of what happens to this hour, on the plantations both in the West Indies and in the United States, and it does not appear, that any serious advances

have taken place in the Asiatic countries, where indeed, from the permanency of their customs, and their great aversion to change, we should not look first, for the improvements introduced by science into the practice of the arts.

The greatest improvement of modern times, perhaps the greatest that has ever been made in the manufacture of sugar, is the introduction of the steam and vacuum process into the plantations, as now practised in Demarara, and, in one instance, that of Mr. Morgan, in Louisiana. The principle, and the most important part of the invention, are the offspring of the genius and science of the late Hon. Charles Edward Howard, improved and applied by Hodgson & Hawkins, and the apparatus constructed and sold by Wm. Oaks & Son, of London. In this country, the vacuum pan of Howard has been still farther perfected, by Mr. Lovering, of the house of Canby & Lovering, of Philadelphia. It is this improved apparatus which is used by Mr. Morgan, of Louisiana. It works, as has been already stated, much more rapidly than Howard's vacuum pan. It ought, however, to be added, that if the crystallization of the sugar is less rapid with Howard's apparatus, it granulates more firmly; which corresponds with the general fact, that crystallization is less perfect, the more rapid is the process. Mr. Lovering believes that the evaporation of the syrup might be rendered almost instantaneous; he once, in seven minutes, evaporated two hundred gallons to the granulating point.

Time and experience, alone, can decide how far, in the actual state of the sugar plantations in this country and in the West and East Indies, the vacuum process can be generally introduced, requiring as it does, a considerable expense in the outfit of apparatus, and some science, skill and judgment in the manufacturer.

When, however, a good apparatus is superintended by competent persons, success is certain; and the causes of failure are always fewer than upon the old plan. The sugar is also decidedly superior in purity, beauty and flavor; and the production of molasses from the decomposition of the sugar by the action of the fire, is much diminished. The uncrystallized syrup that remains, is in a much better condition than it is after being prepared with a higher degree of heat. It contains, however, much more mucilage, &c. and less saccharine matter, but still forms a very fine molasses.

The new process gives the planter a fair chance of sharing, with the refiner, the profits that have been hitherto almost exclusively, his. Sugar can, certainly, be prepared on the plantations in a high degree of purity, and the amount of inferior sugars and the labors of the refiner, can thus be greatly diminished.

It does not appear probable that the introduction of the vacuum process into the plantations, will, however, supersede the business of the refiners, and it may render their labors more simple, easy and effectual, by presenting them a far better material, so that they will be able to begin their processes upon better sugar; better, perhaps, than the middle qualities, and far better than the inferior kinds, which they now prepare and sell from the refineries; of course, the result of the united labors of the plantation and the refinery, will be, the absolute perfection of the manufacture; if, indeed, it has not been already attained. It is probable, however, that a long time will elapse before the vacuum process will be generally introduced upon the plantations, many of which, especially in

Louisiana, are of small magnitude, and of course are possessed of only limited means for making improvements.

That this is the fact, also, in the French West Indies, appears from the elaborate report made by the planters, as well as the refiners, to the French minister of commerce, and of manufactures acting, a few years, since under the immediate orders of the King of France.

Mr. Morgan, of Louisiana, is the only sugar planter in the United States who has introduced, upon the plantation, the evaporation in the vacuum pan. He gives it the decided preference over the old method, both as regards the rapidity and perfection of the process. It is his opinion, however, that in the United States, the manufacture of sugar by the vacuum process, can never interfere materially with the refiners, because the season of working is so short—being confined to the months of November and December; that it is the interest of the planter to work as rapidly as possible, and, therefore, to send his sugar to market in a state which will still need the aid of the refiner to give it perfection.

Most of the sugar planters will, doubtless, continue to proceed in the old way, and many years will elapse before the refiner will find a serious deficiency in the more crude materials which he now employs, and before the planters, if disposed, will be able, to any great extent, to pre-occupy the market, with pure sugars, produced by the vacuum process, upon the plantations. While stating our impressions as to what will probably be the actual state of facts, we do not wish, however, to suppress the opinion, that the general introduction of the vacuum process upon the plantations, where there are adequate means, would be an improvement of primary importance, not only in improving the quality and increasing the amount of the sugar produced, but in diminishing the exhausting labors of sugar boiling, and removing its chances of failure. Mr. Morgan fully sustains the correctness of this opinion.

Among the improvements already described, that are easily obtained in the United States, the bascule pan is the most important, but it is still too slow in its operation; next in importance, is the bascule pan with Kneller's blowing tubes, especially when supplied with warm air; and the means are perfected by the addition of the steam and vacuum apparatus. Those who are unable to purchase the latter, may obtain the two former, or at least the first. We have already stated, that the improved vacuum pans used by Mr. Morgan, in Louisiana, are far more effectual than the original pans of Howard, which are too slow for the short crop time of Louisiana, in which country, despatch in the manufacture of the sugar is of the utmost importance.

With respect to the sugar refineries of the United States, it has been seen, in the preceding statement, that, with a few exceptions, they are still conducted upon the old plan.

The simplicity of the apparatus, and of the process,—the ease with which blood, and clay and lime, are procured—the moderate expense of the outfit, and perhaps, more than all, the sway of long established habit and the prejudices of the workmen, will, probably, cause the old method to be long continued. We have already expressed the opinion, that blood may be used without leaving any disagreeable effect upon the sugar; if employed in a sound state, and with reasonable care, as to cleanliness, it imparts no animal taste or odor, which is perceptible, and the sugar is grateful to the taste, and beautiful to the eye. That it is thus prepared,

in our best refineries, conducted upon the old plan, is apparent from daily experience; and the details of this report, evince, that, by our most respectable manufacturers, every necessary attention is given to order and cleanliness.

It appears, by very recent and authentic information, from France, that the most modern improvements, in manufacturing sugar, have made but partial progress in that country, and they still continue to refine their sugar, principally by the old process, aided by animal carbon. The extensive introduction of that agent, there, as well as in England and other European countries, and the very considerable and increasing use of it in the United States, in clarifying sugar, even where blood is retained, have, however, diminished very considerably, the use of the latter, and given greater certainty and efficiency to the refining processes. The employment of animal carbon, while it is, perhaps, indispensable to the new refining process, is quite compatible with the old, and requires no other change of apparatus than the introduction of the appropriate filters, which have been mentioned in the preceding pages. Animal carbon is a very efficient agent in clarifying, but its use is somewhat troublesome; and the time is anticipated by an eminent manufacturer (as expressed to us) when every clarifying agent will be dispensed with, and the refining of sugar will be effected, solely, by steam and evaporation in a vacuum, for the solution and concentration; and by liquoring for the removal of color, and of all soluble impurities. This, as regards sugar, would be a consummation as desirable as it would be beneficial; and would be the absolute perfection, the beau ideal of both science and art. It does not at all appear extravagant to expect the fulfilment of the anticipations stated above, should the evaporation in the vacuum pans be generally introduced upon the plantations, so that sugar shall come to the market almost without color or impurities.

From all the facts now before us, it is obvious, that there is no room to hesitate between the old processes and the new; the latter must eventually prevail, but the transition will be gradual, both on account of the reasons already assigned, and because there is a great amount of capital invested in the establishments, upon the old plan. Their conversion, however, to the new modes, is not impracticable. The same buildings, with partial changes, would answer, and the old apparatus would to a great extent, be available, either for utensils or materials. It is, however, proper to state, that the expense of the apparatus upon the new plan, is rather more than double of that upon the old.

There can be no doubt that the vacuum process is the true one, for conducting the evaporation both with rapidity and safety; with reasonable care, the syrup can never be injured, and if the previous clarification* has been well performed, the production of good crystallized sugar, with a diminished quantity and a superior quality of molasses, is quite certain. The final purification of the sugar, by liquoring, although, in the opinion of those who use it, decidedly preferable to that by wet clay, is not a necessary peculiarity of the new process; it may be superadded to the old,

*The finings of Howard, or finings of a similar kind, or of some kind, are, generally, used in England, and are still used in New Orleans, but they are not used at all in Philadelphia.

as a subsitute for claying; and it is an important recommendation, that it is effected in one-fourth part of the time.

Liquoring is rendered vastly more effectual by what is called the pneumatic process; that is, by creating a vacuum beneath the vessels containing the sugar, which is to be liquored or drained. This is effected by an apparatus of a peculiar construction, already detailed, and thus the pressure of the atmosphere, by pressing upon the surface of the fluid with its incumbent weight, is made auxiliary to the filtration. The vacuum is, however, not attainable without the apparatus of steam engine and air pumps which are peculiar to the new process. This process may be varied in its details of apparatus and manipulations, but there appears no room to doubt that the principle of evaporation, in a vacuum, with a heat applied by the medium of steam, is the true one, for every extract that is liable to be injured by heat; it is now extensively and successfully employed for other delicate extracts, as well as for sugar, and must always retain the decided ascendency it has acquired over evaporation by the naked fire, and under the pressure of the atmosphere. It is a beautiful application of science to art, and furnishes another example,—in which this age has been fruitful, beyond all former experience,—of a happy union of theory and practice. Thus, the arts and the course of nature furnish facts to science, and science, in its turn illuminates both nature and art.

### *Application of Chlorine.*

Chemists have not been inattentive to the application of chlorine to the bleaching of sugar. Extensive researches have been made on this subject, as may be seen, for example, in the Journal de Physique, &c. of Paris, for July, 1812. We cannot learn, however, that any permanent application of chlorine to the art of refining sugars, has been made, either in France, or in any other country.

We have instituted some experiments on the subject; and it appears that there is no difficulty in rapidly discharging the color of the sugar by the use of chlorine, but there are serious obstacles to the removal of the muriated acid, and, perhaps, of other products, formed between the chlorine and the elements of the sugar. Chlorine is an agent of wonderful activity and energy, and is capable of combining with every element contained in sugar.

On the whole, it is not probable, that these difficulties will be easily overcome, or that any very important improvement will be made upon the process by steam and the vacuum, which, as already stated, appears to be in principle, perfect, and in practice, certain, rapid, and effectual. If a more simple method of forming the vacuum, could be obtained—as, for example, by the steam itself, and its condensation, it would be highly desirable. Practical men, whom we have consulted, are, however, of the opinion that, provided the scale of operation is considerable, the steam engine and air pump are indispensable to the removal of the vapor, formed in a vacuum. The apparatus of M. Roth, already described, will perhaps aid us in forming an opinion.

### *Maple Sugar—Sugar of the Beet.*

The resolution of the House of Representatives, of 1830, in compliance with which the above statements have been made, did not embrace the sugar derived from other sources than the Cane.

The research has, therefore, been confined to this subject, and has not been extended to the sources, which, after the Cane, are the most fruitful and important, namely, the sugar maples and the beet.

We may, however, be permitted to add, that maple sugar (the product chiefly of the Acer saccharinum and of the Acer eriocarpum) would, if manufactured with care, probably afford an excellent basis for refined sugar; but, being prepared in a rude manner in our forests, by simple evaporation, it is seen in commerce only in a very crude and impure state, and the saccharine principle is, more or less, qualified and disguised by other vegetable principles and by earthy matters—no pains being taken to separate them during the evaporation.*

The molasses of the sugar cane is a very rich and grateful syrup, not surpassed, if equalled, by the best syrup of the Cane.

It would be a great national loss, if our maple forests—now rapidly disappearing—should be finally extirpated, and it would be a national blessing, were plantations of these beautiful trees set out, from year to year, that the country may not only be adorned by their shade and symmetry, but enriched by their saccharine juices, which may be drawn from them, for a century, without essentially injuring their vigor.

It is gratifying to observe, that the sugar maple is now planted as an ornamental tree. Long rows and clumps are to be seen adorning the streets and houses, especially on many of the farms and in the villages of New England, as well as in other parts of the country. It is requisite only to extend this very judicious kind of planting to large plantations, and this admirable tree will escape destruction, and may be of great national advantage.

It is well known, that the culture of the beet, in France, was greatly encouraged by the Emperor Napoleon, for the purpose of affording sugar, as a substitute for that from the colonies; that this branch of industry continues to flourish in France,† and that the sugar, even in times of peace, sustains a successful competition with that of the West Indies, in price, and, perhaps in quality. As the beet is congenial to all our climates, and is a sure and abundant crop, perhaps a new source of national wealth may be opened for the cultivator—the manufacturer and the merchant; and thus, between the Cane in the south—the maple in the west and north, and the beet, every where, sugar may be made a great source of public and private emolument. In this view, the subjects of maple and beet sugar may hereafter deserve, and demand a distinct and detailed examination. The facts for maple sugar are to be found in our forests; those for the sugar

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*We are informed that the sugar of the maple has been refined in New York, but, we have never seen a sample; the refined sugar of the beet we have seen and tasted; it was white and agreeable.

†We are not able to say, whether the culture of the beet, in France, could be sustained, against the rivalry of colonial Sugar, were it duty free; this is a question for the politicians, and the same question may hereafter arise in this country, should the beet sugar ever be introduced in the United States as a branch of domestic industry.

of the beet exist in numerous and valuable French publications, rarely seen, however, in this country, except among a small class of readers. A valuable manual on the culture and manufacture of beet sugar, has recently appeared in France, and is now before us.

As the culture of the sugar cane, and the manufacture and refining of sugar, are rapidly advancing and changing, from year to year, the state of facts will soon be in advance of the summary whieh has now been given; occasional revision will, therefore, be necessary. It is hoped, however, that the picture exhibited in the preceding sketch, will be found substantially correct to 1833.

In so extensive a survey—and one involving so wide a range of details, it is, perhaps, too much to hope that no mistakes have been committed in the statement of facts; we can, however, with truth declare, that whatever there may be of error, is unintentional, and, we trust, it will prove unimportant;—while it must be apparent, that the culture, manufacture, and refining of sugar, involve interests of primary and increasing magnitude, in a country whose prosperity is, in many ways, indissolubly connected with the great variety of its natural and artificial productions, and with their friendly dissemination and advantageous exchange, in and through every part of this vast dominion, as well as in foreign countries.

Respectfully submitted to the Hon. the Secretary of the Treasury of the United States,

By his obedient servant,

B. SILLIMAN.

WASHINGTON, *May* 27, 1833.

## STATISTICS OF THE SUGAR CROP IN THE U. STATES.

*In Louisiana.*

From 1820 to 1825, the crops varied from 25,000 to 30,000 hogsheads, per annum, and 1,250,000 gallons of molasses. From 1826 to 1832, they were as follows:

| | *Sugar.* | | *Molasses.* | |
|---|---|---|---|---|
| 1826–'7 | 32,085 | hogsheads, and | 1,604,250 | gallons |
| 1827–'8 | 45,115 | " | 2,255,750 | " |
| 1828–'9 | 87,965 | " | 4,398,250 | " |
| 1829–'30 | 46,000 | " | 2,300,090 | " |
| 1830–'31 | 78,000 | " | 3,900,000 | " |
| 1831–'32 | 73,508 | " | 3,650,000 | " |

The crop for 1832 and 1833 has not yet been ascertained; but in consequence of the severe frost in November, it is believed that it will not much exceed the crop of 1829 and 1830.

*In Georgia and Florida.*

No measures are taken, in this part of our sugar district, to ascertain the amount of crops: we are therefore able only to give a general estimate of the produce of this year, from facts furnished us by a few of the principal planters. From this source we should place the crop of 1832 and 1833, at 2,000 hogsheads, of 1,000 pounds each.

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*Errata and alterations from copy.*

Page 80, Title—for *Teaman* read *Seaman.*
" 81, line 23, from top, for *access* read *excess.*
" 82, line 14, from top, for *former* read *the pans.*
" 84, line 10, from top, for *tube* read *tubs.*
" 84, line 19, after *braces* read *in the coolers.*
" 84, line 9, from bottom, after *farther* add *under the evaporating process.*
" 88, line 4, from top, for . *T* read *; t.*
" 88, line 6, from top, before *superior* read *is.*

THE END.